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The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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Contents

	PAGE
Science in the Press	351
Physical Chemistry and Foundry Practice	351
The Institute of Vitreous Enamellers	352
District Presidents.—No. 13	352
Correspondence	352
Random Shots	352
Experiences in the Manufacture of High-Grade and Alloy Cast Irons	353
Castings for Laundry Machinery	357
Bells and Cannon	357
Enabling Bill for Promoting Industrial Reorganisation	358
Industrial Lighting in Sheffield Foundries and Steelworks	358
Practical Sand Control	359
Elucidating Foundry Problems	361
The Casting Skin	362
Continental Steel Cartel	362
This Week's News in Brief	364
Trade Talk	364
Contracts Open	364
Company Reports	364
Personal	364
Obituary	364
Raw Material Markets	366
Publication Received	366
New Company	366

Science in the Press

It is becoming platitudinous to say that science is transforming the world in which we live and exerting an ever increasing influence upon the welfare and occupations of mankind, but a somewhat different aspect of this state of affairs was touched upon by Lord Rutherford at the recent annual dinner of the Institute of Journalists. In referring to the part played by the Press in interpreting the workings of the scientific mind to the public, he urged the devotion of more attention to scientific articles suitable to the type of public which is growing up, and is now able to absorb scientific matter other than that written in baby language.

Now, whatever the merits of those journals which are professedly devoted to scientific interests and pursuits may be, it cannot be denied that the general reading of the public, as represented by the daily newspapers, falls far short of the ideal in the presentation of scientific news. The deeds and misdeeds of the popular Press are nowadays considered fair game for captious critics of all kinds, but the manner in which scientific and technical matters are reported in the great majority of cases constitutes one of its most serious shortcomings. For the most part this section of the Press seems incompetent to discuss anything falling between the two extremes of astronomy and atom splitting. The lay reader is constantly being plied with what is called the new world picture of modern physics, a subject which without doubt is most inaccessible in his daily round, and of which he is usually quite unable to grasp the significance. On the other hand, the enormous range of knowledge upon which his life and comfort are actually based is allowed to go unnoticed. Despite the great interest taken by the layman in the superficial features of the motor car and the aeroplane, for example, he remains in gross ignorance of the simple principles of the design of these forms of transport or of the details of their materials of construction.

The crudeness with which the few technical matters which do find their way into the newspapers are expressed is usually laughable, if not pathetic. There will be few metallurgists or foundrymen likely to forget the graphic accounts of the casting of the lead keel of the "Endeavour," for example, when workmen emerged reeling from the acrid fumes, and the heat was so terrific as to melt a piece of pig-iron supporting the furnace. Again, the frequency with which new bullet proof metals, or alternatively new armour-piercing bullets, are discovered would be most disconcerting to government metallurgists were these discoveries as revolutionary as they are made to appear from the Press accounts.

There are many otherwise educated men and women whose ignorance of scientific and technical matters would cause them deep shame if it applied to topics of a literary or artistic nature, and the daily Press, while supplying these people with full discussions on questions of literature, art, music, the theatre, finance, and so on, makes no attempt to render a similar service on the scientific side. There is an equally important need for such instruction in elementary scientific and technical matters if developments in this sphere are to be followed with any appreciation and understanding.

Physical Chemistry and Foundry Practice

In a recent address to the London Section of the Institute of Metals, Dr. Harold Moore referred to the increasing part played by the methods of physics and physical chemistry in metallurgical development, and went on to discuss, amongst other things, some of the effects of research on the melting and solidification of metals in practice. As far as foundry practice is concerned, this is a feature which we have always looked upon as of greater significance than is generally realised. The physical chemistry laboratory may seem to many foundrymen to be remote from the realities of the foundry, but the factors governing the transfer of molten metal from ladle to mould, and the subsequent solidification process, are essentially physico-chemical in nature, and it is clear that in the near future the application in foundry practice of modern views on such subjects as viscosity and the mechanism of crystal growth will have to be prosecuted by those most capable of their exposition.

A considerable amount of valuable work has been carried out on the Continent, notably by Professor Portevin and his associates, upon the physical and chemical factors underlying the process of solidification and the property of *coulabilité*, but a great deal remains to be done in order to enable the foundry metallurgist to consider his problems against a background of sound physico-chemical ideas. There is a wealth of knowledge on the fundamentals of melting and freezing, which is being daily increased by pure research workers who probably have little or no knowledge of, or interest in, such problems as are met with in the foundry, but whose work is yet of great potential value to the foundry

XUM

industry. A case in point is the recent work of Professor Andrade on the viscosity of liquids and its variation with temperature. In addition to providing us with an entirely new concept of the structure of liquids and the mechanism of the transfer of momentum, he has been able to express viscosity coefficients in terms of atomic weight, melting point, and atomic volume at the melting point, without the use of an arbitrary constant. There remains a real need for the exploitation of fundamental work of this kind by the type of metallurgical research worker who is capable of dealing with both the pure physico-chemical aspect and the practical foundry side of the question.

It may be hoped that, when the foundry course inaugurated by the University of Sheffield has acquired sufficient momentum and prestige, such important phases of the underlying science of foundry work may be tackled by the research workers who will be attracted to Sheffield. There should be a rich harvest of developments and improvements to be reaped from the seeds that are being sown by the pure researches of the physical chemists.

The Institute of Vitreous Enamellers

NEW MEMBERS ELECTED

The Institute of Vitreous Enamellers has elected the following to various grades of membership:—

Ordinary Members.

William Thomason, F.I.C., chief chemist and managing director of J. F. Stewart & Company, Limited, Paisley Works, Swains Road, Tooting, London, S.W.17.

George Leslie Thompson, B.Sc., technical representative, Clifford Christopherson & Company, Limited, 116, Corn Exchange Buildings, Cathedral Street, Manchester.

Albert Alfred Mead (company director, Mead, McLean & Company, Limited), South Vale House, Blackheath, London, S.E.3.

Associate Member.

Albert M. Cleverley (manager, Rustless Iron Company, Limited, Keighley), 83, Ashleigh Street, Keighley.

Associate.

H. L. Hartley, sales engineer, Broom & Wade, Limited, 7 to 8, Norfolk Street, Strand, W.C.2.

Subscribing Firms.

Fairways, Limited, 102, Westferry Road, London, E.14. (Representative, Mr. N. D. Brown.)

Vack Industries, Limited, Mill Street, Kingston-on-Thames. (Representative, Mr. W. R. Gibson.)

E. J. & J. Pearson, Limited, Stourbridge. (Representative, Mr. C. A. G. Thomas.)

British Titan Products Company, Limited, Billingham, Stockton-on-Tees. (Representative, Dr. G. F. New, Ph.D., F.Inst.P.)

Grahamston Iron Company, Limited, Falkirk, Scotland.

Iron or Mild-steel Wire for Welding Purposes

The Air Ministry has issued material specification D.T.D. 82A (superseding specification No. D.T.D. 82) for iron or mild-steel wire for welding purposes. The chemical composition of the wire shall be (per cent.):—Carbon, 0.10 (max.); manganese, 0.60 (max.); nickel, 0.20 (max.); sulphur, 0.05 (max.); phosphorus, 0.05 (max.). The complete analysis of every cast shall be supplied to the Inspector. The wire shall work satisfactorily when used as a welding rod, and shall not foam or splutter.

District Presidents.—No. 13

SHEFFIELD BRANCH OF THE INSTITUTE OF METALS

Mr. Kenneth Gray was educated at Chelsea Grammar School and St. Mark's College, Chelsea. Afterwards, at London University, he took courses in civil engineering and sanitary science in connection with cold-water supplies, heating and ventilation. He became a member of the Junior Institute of Engineers in 1890, being appointed chairman in 1902. In 1901 he joined

MR. KENNETH GRAY.

the Royal Sanitary Institute, and became a Fellow in 1931. He is a Past-President of the Institute of Heating and Ventilating Engineers. At present he is a member of the Council of the Institute of Metals.

Mr. Gray is a director of Mellowes & Company, Sheffield and London, and a Governor and member of the Applied Science Committee of the University at Sheffield.

Correspondence

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Foundry Costing

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—"Interested" asks the question if scrap is to be determined by the value of the mixture, and I think he would be well advised to assume that it is, for these reasons.

Most foundries in good practice absorb their own scrap the following day, therefore the answer is quite definite; conversely, should they accumulate shop scrap, on the same or any other basis, there is no need to purchase outside scrap until this is consumed, and the problem becomes a simple one.—Yours, etc., G. MORAN

(Manager, The Reliance Foundry Company).

Wednesday, December 3, 1934.

The Permanent Mould Process

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In describing some of the works visited at the recent International Foundry Congress in your issue of November 22, I referred to the method of coating permanent moulds at the Eaton-Erb Foundry Company as being by oxy-acetylene flame; this should, of course, have been stated as acetylene flame, as obviously an oxy-acetylene flame would probably melt the mould.—Yours, etc., YOUR CORRESPONDENT.

Random Shots

Although not a participator in the golden harvest which many speculators on the Metal Exchange must have gleaned from the recent rapid rise in copper, "Marksman" has been thrilled by the glamour attaching to dabbling in futures. "Marksman" even went on a pilgrimage to Whittington Avenue with a view to inhaling this atmosphere of getting rich quickly, but the proximity of Leadenhall Market proved too strong, and quite a different "air" tuned in! On reflection, "Marksman" feels that dealing in futures ought to be extended, for the present opportunities embracing metals, rubber, cotton and wheat seem unduly restricted in the midst of a highly civilised community.

* * *

What about an Egg Exchange? Doubtless other people share "Marksman's" opinion that many an egg would be all the better for being exchanged, and trading in futures should be popular, particularly if members brought a bag of samples with them, and started swapping deliveries across the ring! Bull operators would have their chance when an election came along, and the increased demand would give holders the chance to work off some of their old stock. It is a moot point which would be higher, the price or the egg! "Marksman" wonders what the backwardation would be between new-laid and addled specimens.

* * *

Is it not about time, too, that business in umbrellas was regularised? They are always being exchanged in a haphazard kind of way through the medium of restaurants, trains and clubs, but a recognised trading centre would give point to these transactions. Incidentally, you could always give the other fellow the point—in the small of his back—if you found him making off with your property. As to trading in futures, well, we are always being advised to make provision against a rainy day, so there seems to be an argument for buying "three months' umbrellas." As a matter of fact, "Marksman" finds it difficult to hang on to his for three weeks! Certainly the market would not lack life, for inevitably it would always be going up and down!

* * *

Then what about the cry of "Any old rags, bones or bottles"? "Marksman" would like to hear that classic challenge echoing under the vaulted roof of some noble building dedicated to the ancient trade of the junk dealer, suitable provision being made outside for parking the barrows. Here in one corner is a wardrobe dealer. "What about going long in trousers, or perhaps you do not fancy the market, and would rather be one of the shorts? You prefer to go bear? Really, my dear sir, I cannot advise it, for you would undoubtedly be taken up very quickly. A dabble in bones? You are taking a very narrow view, I fear. These skeleton operations rarely turn out well, and, generally speaking, bring little meat to the operator. You want to buy three bottles, sir? Sorry, there is no off-licence here." "Marksman" believes the scheme would be a real success if only because it would give husbands a chance to retrieve those favourite old suits given away by wives in exchange for a flower in a pot!

* * *

One more suggestion which surely must commend itself to every marksman. Bull's-eyes! A strong market, gentlemen, the aroma of which mounts up to heaven—and every bull's-eye is as good as the mint! Among junior operators the bull's-eye has no future, for it is chewed up quickly, but your cautious middle-aged masticator makes it last for three weeks. Poor wretch; he can't get rid of it! Every boy chews bull's-eyes, so let your son choose it as a career, if he has enough cheek to make a success of it!

MARKSMAN.

Experiences in the Manufacture of High Grade and Alloy Cast Irons*

By P. A. Russell, B.Sc.

There have been many Papers on the properties and advantages of these irons, but few of them have dealt with these irons, particularly alloy irons, from the producers' point of view. The experiences given cover the production of castings for general engineering purposes, particularly machine tools, and, in the case of the alloy irons, for many general applications, mostly of a non-repetitive nature.

It should be understood at the outset that in referring to high grade irons, that the Paper does not deal with the special high tensile and similar irons of the innoculated type, but with the production of engineering cast irons with tensile strengths from 12 tons to 18 tons sq. in., the principal qualities required being soundness, fine graphite size and uniformity.

The production of this class of casting requires an iron in which the carbon is below, often well below, the eutectic point. Several formulæ have been put forward to determine the carbon content of the eutectic, and the author has found that the simple one of $C = 4.3 - \frac{Si + P}{3}$ to work quite well; thus an iron with 2 per cent. silicon and 1 per cent. phosphorus has about 3.3 per cent. carbon at eutectic composition. The further the carbon is below this composition, the better the iron is for soundness, strength, uniformity of hardness, etc. In producing these irons the usual methods of silicon control are necessary, but these are too well known to be enlarged upon here. The author is familiar with the work of the Institute's Cast Iron Sub-Committee on total carbon and phosphorus, but, for economic reasons, most of the practice with which this Paper deals has been developed around irons with phosphorus between 0.7 and 1.0 per cent.

FIG. 1.—PIECE OF STEEL RECOVERED FROM CUPOLA.

To produce high grade cast iron, carbon control must be exercised along with the usual silicon control. Most of the ordinary brands of pig-iron, whether phosphoric or not, as produced in the modern high-output blast furnace, have carbon rather in excess of the eutectic amount, and it is necessary to reduce this by means of special pig-irons, refined irons, steel, or a combination of these. The two former materials are comparatively expensive, so that steel is used in the cupola wherever possible.

* A Paper read before a joint meeting of the London and East Midlands Branches of the Institute of British Foundrymen, Mr. A. S. Beech presiding.

Cupola Conditions

It is proposed to deal first with the production of irons that have carbon of about or just under the eutectic amount, and have physical properties rather in excess of those required to meet B.S.I. Grade A Specification 321. These irons can be poured into moulds that are made in the ordinary foundry routine and require no special feeding.

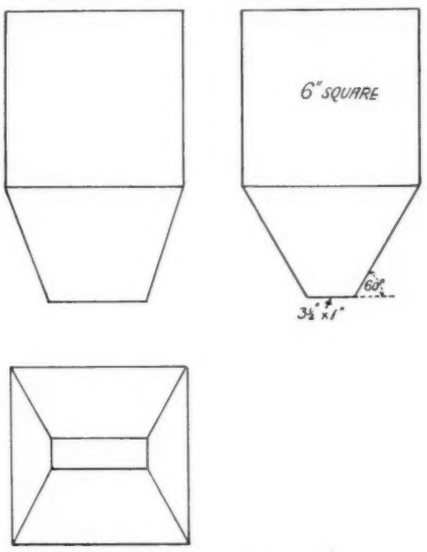


FIG. 2.—FEEDER RISER.

The amount of steel that can be used in the cupola for this purpose depends on two factors:—(1) the cupola conditions, and (2) the composition of the balance of the charge. The conditions required in a cupola to ensure minimum carbon pick-up are well known and can be summarised as quick melting with the correct amount of air, and quick tapping. The effect of the various types of coke or carbon pick-up are not yet thoroughly understood, but hard cokes seem to give the best results, probably owing to their quick melting properties. If the cupola be operating under these conditions then the amount of steel that can be used for this class of casting is quite small. Personal experience shows that 10 to 12 per cent. is the limit.

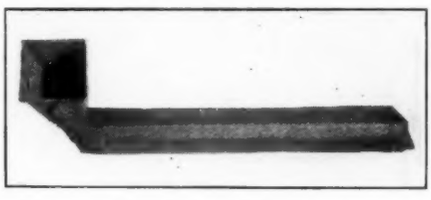


FIG. 4.—ALLOY SHUTE.

If special precautions are taken to ensure a high carbon-pick-up, then larger amounts can be used.

Naturally, the second factor, that of the composition of the balance of the charge, is important. Irons containing carbon much in excess of the eutectic amount can carry a fair amount of steel, whereas irons with carbon under the eutectic amount cannot be used with steel for this class of casting.

To obtain tensile strengths of over 14 tons per sq. in. and Brinell hardnesses of over 200, in sections 1 in. thick and over, it is necessary that the carbon should be reduced distinctly below the eutectic amount. To produce this class of iron from steel and ordinary irons requires a cupola that is very well preheated and closely controlled for air supply. Excess air produces oxidation and consequent increase of shrinkage troubles, and insufficient air gives slow melting. If the cupola be controlled to give its theoretical melting rate, then the air supply is about right. The amount of steel required to produce these results varies from 20 to 50 per cent., according to the carbon reduction required. The manganese content of the accompanying pig-iron must be kept high. Bought scrap iron of unknown source cannot be used owing to its uncertain composition.

In addition, great care must be taken to ensure that the different parts of the charge are adequately mixed in the well or receiver of the furnace before tapping. The constituent parts of the charge melt at different rates, particularly when phosphoric irons are used in the mixture. Thus, if the iron be tapped in small quantities and the furnace frequently drained, then an irregular product is bound to result. As it is desirable to get the metal out of contact with coke as quickly as possible, this is apt to become a vicious circle when working a cupola without a receiver.

Carburisation of Steel

The author has been investigating the mechanism of the melting of steel in the cupola, and microscopic examination of the edge of a piece of steel that was just starting to melt shows that the carburisation of the steel does not commence before melting. The piece of steel from which this was taken is shown in Fig. 1, the analysis showing the carbon to be 0.14 per cent.

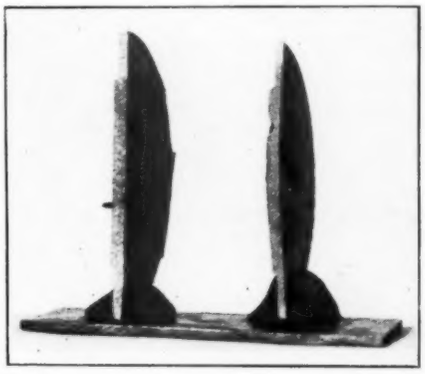


FIG. 3.—LIGHT CASTING WITH (RIGHT) AND WITHOUT (LEFT) A 2 PER CENT. NICKEL ADDITION.

The risks and irregularities consequent upon the use of large amounts of steel often make this process much more expensive than would appear at first sight, and it then becomes a matter of economics as to whether special or refined iron is used instead of steel or not. Thus, the greater cost of these materials is often counterbalanced by the greater certainty of obtaining a regular product. If these special irons be used, care is still required in melting to prevent excessive carbon pick-up, for the benefits of low-carbon irons may be entirely neutralised by bad remelting.

An alternative that is becoming increasingly popular is for the foundry to make its own refined pig-iron from charges high in steel. The use of soda ash facilitates this process, as sulphur pick-up can be counteracted.

Feeding Low-Carbon Irons

With these low-carbon irons the troubles of the producers of castings are greatly increased.

The apparent solidification shrinkage of these irons is much greater than that of ordinary grey iron. This is largely due to the lesser amount and smaller size of graphite formed. Thus, the foundry practice has to approximate more to that of malleable than ordinary grey-iron practice. Personal experience has been that risers of the self-feeding type are one of the most satisfactory ways of dealing with this. If the

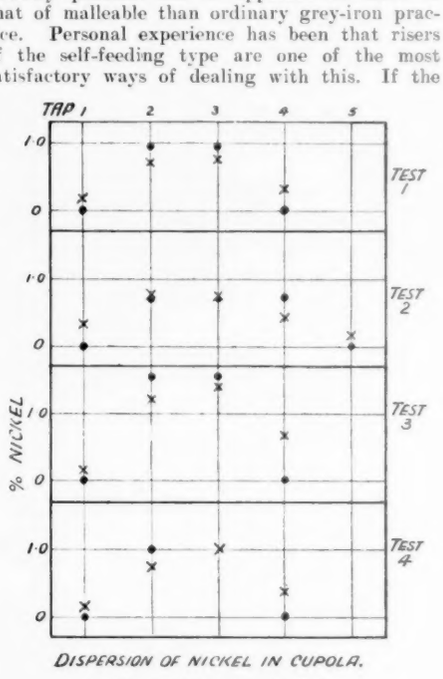


FIG. 5.—DISPERSION OF NICKEL IN CUPOLA TESTS, 1 TO 4.

risers can be transformed into runners by means of strainer heads, so much the better, as the hottest metal is in the feeder, where it should be. A typical riser is shown in Fig. 2. If it is necessary to run the casting near the top, then feeder knobs should be placed at the back of the ingate. Unless feeding by the runner is attempted, the runner should be placed at the thinnest part of the casting, if practicable.

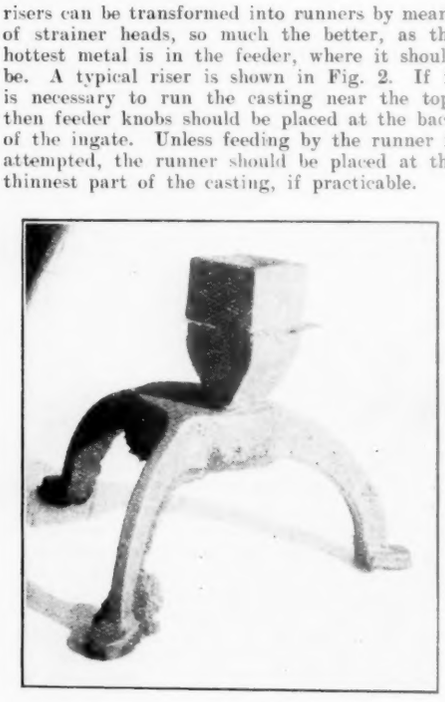


FIG. 8.—THREE-LEGGED STAND IN NI-RESIST CASTINGS, WITH FEEDERS ATTACHED.

Dry-sand moulds are to be preferred for the following reasons: (1) The high pouring temperature required for this class of iron tends to fuse the face of green-sand moulds; (2) their rigidity helps to divert the expansion due to the formation of graphite to an inward direction, instead of an outward direction as in the case of green-sand moulds, thus to some extent counteracting the shrinkage, and (3) troubles due to the concentration of shrinkage at certain points of the casting due to localised gas pressure are reduced. For the same reason adequate venting of the cores and moulds is essential.

Personal experience is that denseners are still necessary to compensate for irregularities of section, though the lower the carbon is below

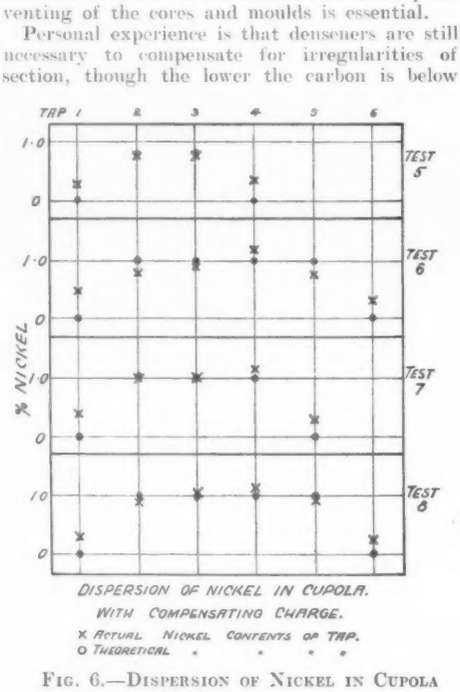


FIG. 6.—DISPERSION OF NICKEL IN CUPOLA TESTS, 5 TO 8.

the eutectic point the less these are required. To summarise this—as the carbon passes from amounts above the eutectic points to amounts below, the shrinkage changes from an internal porosity to external sinking.

Production of Alloyed Cast Irons

To turn to the production of alloy cast irons, it is proposed to deal first with the production of irons with low alloy contents, in which the amount of alloy is insufficient to change the iron from its usual ferritic or pearlitic condition. The most common alloying elements are nickel and chromium. Many other elements are now being used, but personal experience to date is confined to these two, with the exception of silicon, which can be regarded as an alloy in such irons as Silal, and copper, which is incidental to Ni-Resist.

FIG. 9.—VALVE IN NI-RESIST CASTINGS, WITH FEEDERS ATTACHED.

It is not sought to discourse upon the advantages of the use of nickel and chromium, but nickel and chromium together have been found very useful in producing fine grain, uniformity of high hardness, good wearing properties and strength, or separately give graphitising or chilling effects.

It is best to use nickel and chromium together wherever possible, in the usual proportion of 3:1, as it is then unnecessary to effect the silicon reduction that is involved in the use of nickel alone. Silicon reduction usually means carbon increase, which is undesirable. On the other hand, nickel can be used as a softener where exceptional conditions make this desirable. For instance, one occasionally gets a call

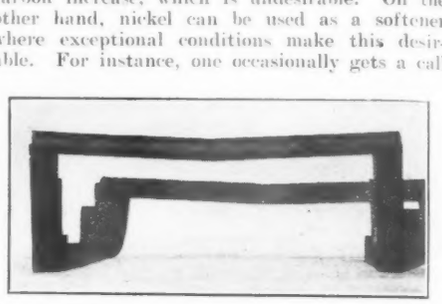


FIG. 7.—TRANSVERSE TEST-BAR IN NI-RESIST.

for extremely thin castings, which are chilled if cast in 2.5 per cent. silicon iron, which is the highest silicon normally run in the author's foundries. These castings are made from this 2.5 per cent. silicon iron, with 2 per cent. ladle addition of nickel. The result is shown in Fig. 3. Similarly a cheap but effective heat-resisting iron can be made by adding sufficient chromium to a low-silicon iron to cause the castings to run white.

Introduction of Alloys

The first essential in the creation of alloy cast irons is the production of a good base iron. This is one of the reasons why this subject has been dealt with rather fully in the first part of the Paper, at the risk of repeating what is fairly common knowledge. Then comes the question of how to introduce the alloys. The available methods are: (1) Ladle additions; (2) additions to the cupola charge of alloys in a concentrated form, and (3) use of pig-iron containing the necessary amount of alloys.

Ladle additions have the great attraction of certainty, but the disadvantage of cooling the liquid metal. The use of concentrated alloys in the cupola is to be avoided wherever possible and the remelting of iron to give the exact composition required is the best way, providing that the quantity required is sufficient and the expense of preparing or buying the material is warranted.

Very satisfactory results can be obtained by using ladle additions. A high tapping temperature is required, and the alloys should be in as concentrated a form as possible, compatible with low fusion point. Personally, the author uses the standard "F" nickel shot and 70 per cent.

FIG. 10.—BOX OF SMALL PARTS IN NI-RESIST CASTINGS, WITH FEEDERS ATTACHED.

ferro-chrome (4 to 6 per cent. C.), powdered to pass 40-mesh sieve. To ensure that the correct amount of base iron is tapped to suit the predetermined amount of alloy, it is desirable that the ladle should be suspended from a weighing machine. A shute of the form illustrated in Fig. 4 is used, and the alloys introduced into

the stream of metal coming down the spout, at a point as near the tap hole as possible, preferably at a point where there is some turbulence in the stream. This is to be preferred to the fixed-hopper method, as the alloys can be directed into the stream. The alloys are introduced into the first half of the tap. By these methods up to 2½ per cent. of nickel and 0.8 per cent. of chromium can be added.

The author has never found any difficulty from the lack of diffusion of the alloys. But he must repeat that the metal must be tapped at a very good super-heat to carry such a large amount of addition, which is over 4 per cent. of the total and incurs considerable temperature reduction. Nickel is more easily introduced than chromium, and can be added without any allowance for loss. The fineness of the ferro-chrome powder renders it very liable to be carried away by hot-air currents, and it tends to float on the surface of the metal in the ladle in cakes. These should be broken up by a stirrer, or preferably pushed under the descending stream of metal. The chromium loss may vary from 5 to 15 per cent. of the amount added.

It is preferable to introduce as much of the alloys as possible into the cupola charge by means of re-melted runner heads, etc. Thus, the ladle additions are reduced to the amount necessary to alloy the new metal part of the charge and make up for chromium losses in remelting the runners. Also, if chromium additions above 0.5 per cent. are required, the best way is to use a chromium-bearing pig in the charge.

If the whole of a cupola blow be devoted to the production of one class of alloy iron, there are no particular difficulties in securing an accurate product, but if only a part of the melt consists of alloy work, then extra care is required. If the castings to be produced be fairly heavy, the alloy metal can be melted first, followed by the ordinary blow, or *vice versa*. Some people blow the furnace right down, drain the furnace, put on a fresh bed of coke and start again. This is not so easy as it sounds.

Separating the Charges in Cupola Practice

Wherever possible, it is preferable to run alloy irons in a separate melt, grading the different types into one another in the same way as ordinary irons. In one recent melt the author produced five different qualities of alloy irons from two base mixtures, making the differences by ladle additions.

If the castings are light and the quantity insufficient to warrant a separate melt, sufficiently hot metal cannot be produced at the beginning of the melt to avoid a fair amount of discard. Thus, it is necessary to introduce the alloy charges after a certain amount of ordinary iron has been run through the furnace. Then the difficulty of the separation of the charges becomes acute. The complete separation of the charges in a cupola, without serious interruption of the melt, is impossible. With regard to ordinary irons, this is best overcome by the gradual up or down grading of the mixture. There is always an intermediate grade between two types, but with proper discretion this can usually be dealt with. When alloy irons are used in which the whole or part of the alloy content is in the cupola charge, there is bound to be some of the alloy appearing in the preceding and succeeding taps of metal, with a consequent deficiency in the alloy taps. Fig. 5 makes this clear. In this instance, large quantities of excess coke were used in an attempt to separate the metals, but was of little help. In this example a quantity of ordinary iron was run first, which was used to obtain a general warming-up of the furnace and ladles, and could be used for unimportant castings. Accurate timing and weighing of all metal tapped from the furnace was used to control this. The effect of an error in timing is shown in Test 2, where the metal was tapped too late, causing the nickel to be concentrated in the earlier taps. The nickel figures shown are irrespective of ladle additions.

Then a charge of metal was introduced before and after the alloy charges, which was in the nature of a charge for producing refined iron, and this absorbed the wandering alloy. This refined iron was then used on the following day as part of the alloy-iron charge, its alloy content being neglected in the calculations, and the deficiency was replaced. The results of using this method are shown in Fig. 6.

If only small quantities of alloy iron be required, and a suitable base iron is being run in the ordinary cupola melt, these can be made quite satisfactorily by ladle additions alone, within the limits given above. The runners so produced can be used up on occasions where larger quantities are required, or, if the nickel and chromium be balanced, used up in the ordinary standard iron. This latter involves the loss of the value of the alloys in the runners. With regard to the preparation of moulds for this class of alloy work, no alteration need be made in the practice given above for high-grade irons.

FIG. 11.—DRUM IN NI-RESIST CASTINGS, WITH FEEDERS ATTACHED.

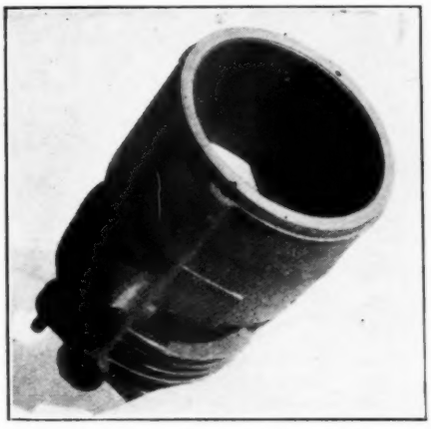


FIG. 14.—CYLINDER IN NICKEL-CHROME CAST IRON.

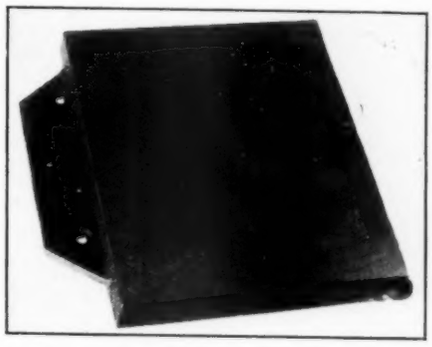


FIG. 16.—HOTPLATE IN NICKEL-CHROME CAST IRON.

FIG. 12.—NI-RESIST FEEDER, BORED OUT, SHOWING SHRINKAGE.

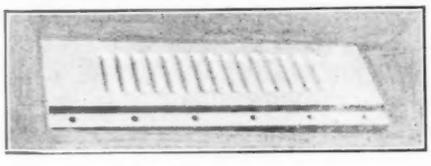


FIG. 13.—PRESS TOOL BLOCK IN NICKEL-CHROME CAST IRON.

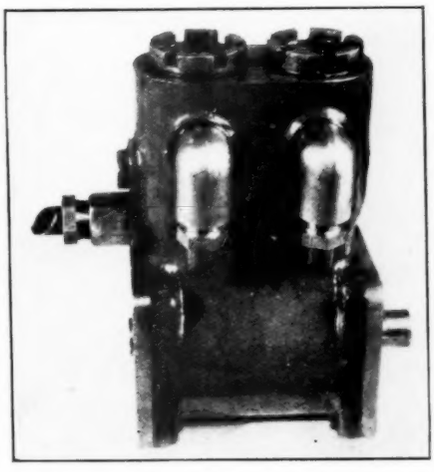


FIG. 15.—HYDRAULIC SAW VALVE IN NICKEL-CHROME CAST IRON.

FIG. 17.—HEAT-RESISTING POT IN NICKEL-CHROME CAST IRON.

Other Alloyed Cast Irons

To turn now to the alloy irons in which the alloy introduced is sufficient to modify the basic structure of the metals. Those of which personal experience has been had are as follow:—(1) Irons with nickel about 3.5 per cent., which are made martensitic by heat-treatment. These can be produced by ladle addition methods, providing there is at least 1 per cent. of nickel in the metal tapped from the cupola. (2) Irons that are martensitic as cast (Ni 4.0 to 4.5 per cent., Cr 1.5 per cent.). Personal experience with this has only been with crucible melting, which presents no special problems, but it would appear that cupola-melting methods on the lines given above could be adapted to suit this metal. The low carbon and low silicon sometimes employed for this class of alloy iron necessitates adequate feeding and precautions against cracking, similar to malleable methods. (3) Austenitic cast irons of the Ni-Resist type (Ni 14 to 16 per cent. Cu, 5 to 6 per cent., Cr 2 to 5 per cent.).

FIG. 18.—CAM, HEAT-TREATED, IN NICKEL-CHROME CAST IRON.

The author has produced this material (No. 3) by both crucible and cupola methods. Dealing with the cupola first, it is considered essential to devote the whole of a cupola melt exclusively to the production of this iron. The cupola should be thoroughly well preheated, and oxidising blast conditions avoided. The charge is made up of a suitable base iron, together with nickel-copper-chromium pig; Monel metal can be used, but no personal experience of this has been had. Remelt up to 50 per cent. of the charge may be carried. Low-carbon base iron is not necessary, and no steel is required in the charge. If chromium above the amount given by the Ni-Cu-Cr pig be required, then a chromium-bearing pig should be used and ladle additions avoided.

FIG. 19.—VALVE IN AUSTENITIC CAST IRON.

Silicon and manganese losses are rather heavy—about 15 per cent.—and sulphur gains considerable. Chromium losses are also considerable, and vary with the concentration of chromium in the charge, high concentrations giving high losses. Nickel and copper losses should not occur, but under bad melting conditions, some of the melted Ni-Cu-Cr pig will freeze as it comes into contact with the cold air at the tuyeres, and so will never reach the well of the furnace.

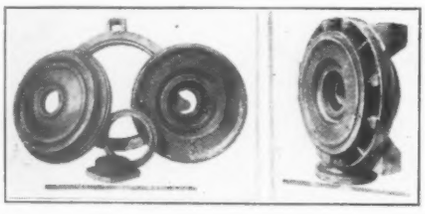


FIG. 20.—PUMP PARTS IN AUSTENITIC CAST IRON.

For crucible melting, personal experience is that silicon, manganese and carbon losses and sulphur gains occur when melting Ni-Resist scrap, so that allowances have to be made for these to almost the same extent as in cupola practice.

Casting Austenitic Cast Irons

The foundry technique for pouring austenitic irons requires a great deal of attention to be paid to feeding arrangements. An extension of the methods given earlier in this Paper is required, and the feeders require to be heavier and less necked. This, together with the toughness of the material, frequently makes the removal of these risers a difficult proposition. This toughness is illustrated in Fig. 7, which shows a ⅜-in. dia. test-bar just beginning to crack in a transverse test.

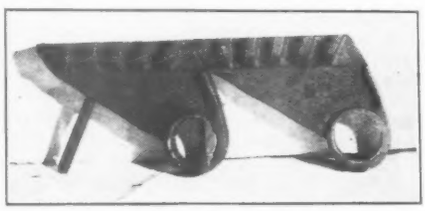


FIG. 21.—STOKER LINKS IN AUSTENITIC CAST IRON.

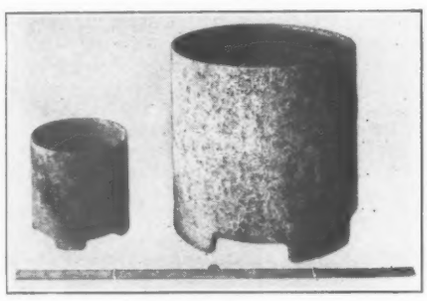


FIG. 22.—CARBURISING POTS IN AUSTENITIC CAST IRON.

Denseners can be used to accelerate the cooling of parts that cannot be reached by a feeder, but denseners alone on castings that have any considerable masses of metal are useless. They may give surface soundness, but the inside of the casting will be hopelessly "drawn." A judicious arrangement of denseners in the heavy sections in the bottom of the mould and feeders on the heavy sections in the top of the mould is the most satisfactory way. The cross-sectional area of the feeder should be greater than that of the heaviest part of the casting. High-chromium austenitic irons need more feeding than low-chromium ones, presumably on account of the lesser amount of graphite formed.

The moulds are usually in dry sand for safety and ease of running thin sections. Dry-sand feeders are more effective than green-sand, and every effort should be made to keep the feeder as hot as possible, so that it is the last part to solidify. The metal has little "life" and should be poured as hot and as quickly as possible. Figs. 8 to 12 show methods of running and feeding austenitic iron castings.

Castings of thin sections or with high chromium should be heat-treated to give ready machinability. This treatment is very simple and consists of soaking at 850 deg. C. for ¼ to 1 hr. according to the thickness of the job and then cooling in the furnace or in air, preferably the latter. The carbides are thus broken down and the ductility of the metal much improved. No reference has been made to the production of Silal or Nicro-Silal, as these are not of such general interest.

Finally, Figs. 13 to 22 show a few illustrations of castings made of alloy iron produced by the methods outlined in this Paper.

It is thought that the foregoing remarks go to prove that the production of alloy cast irons is very largely a specialist's job. The more alloy iron of any one type that can be produced from one melt, the more satisfactory and regular the product is likely to be. Personal opinion is that a new branch of the foundry industry is developing to deal with alloy irons. Each branch of the industry, such as rain-water goods, stove-grate, automobile and engineering castings has its own particular problems, both technical and economic, and these have been best solved by specialisation.

In conclusion the author wishes to thank his co-directors of S. Russell & Sons, Limited, for permission to produce this Paper, and the staff for their assistance in its preparation.

New Foundry in Palestine

The Palestine Foundries and Metal Works in Emek Zebulun (Haifa) consist of an ironfoundry, enamelling works, engineers' shop, and rolling mill. The ironfoundry and the enamelling works have now been completed, and commenced operations in November; the engine works and rolling mill will be completed next year. The works are constructed with the latest technical improvements and the workshops are installed with the newest plant and equipment. The machinery has been imported largely from America, England and Czecho-Slovakia. The foundry will have large furnaces run on oil. The raw material, where not available locally, has been imported from England. The company was registered on January 28, 1934, with a capital of £P30,000 (fully paid up); this was raised to £P45,000 at the general meeting held on November 5. The majority of the shares (£P16,750) are in the hands of the Kremener group—Mr. Kremener is a former director of the Hartung A.-G. in Berlin, belonging to the A.E.G. concern—while the remaining share capital is held by a Palestinian group representative of the Palestine Electric Corporation (Rutenberg), Nesher (Pollak), Julius Simon, New York (Brandeis group), and Ezrah Shahmoon. Mr. Alexander Kremener will act as managing director. The management board comprises Mr. Aleinikoff, Haifa, Dr. Aron Barth, Haifa, Dr. Soloweitschik (A.P.B.), Haifa, and I. S. Shapiro (Rutenberg), Tel Aviv. It is intended to begin with the production of cast-iron sanitary ware, baths, enamelled cast iron, cast-iron pipes, rain-water fittings, and wash basins. In addition, all sorts of castings for machinery will be manufactured. The Government has shown active interest in the new enterprise. The output of the works will be protected by a duty of 12 per cent. The initial productive capacity of the Palestine foundries will be 200 tons per shift.

Castings for Laundry Machinery

DISCUSSION AT NEWCASTLE-UPON-TYNE

The importance of iron castings for laundry machinery was emphasised at a meeting of the Newcastle-upon-Tyne Branch of the Institute of British Foundrymen by MR. J. LONGDEN, who delivered a lecture on the subject. The Paper has already appeared in full in THE FOUNDRY TRADE JOURNAL of November 23 and 30, 1933. The discussion which followed the lecture shows that certainly some members found that their problems are not isolated cases.

MR. F. ROBSON (President) was in the chair, and opened the discussion by referring to the chills of the cores used in the ironer beds. He wished to know if these were blacked, and if so, if there was not a tendency to blow-holes? To this, the lecturer replied that the chills were blacked on the outside and about 4 in. up on the inside, the reason given for leaving the remainder unblacked being that they were difficult to dry on the inside. Regarding the practice of blacking, it was not generally liked.

MR. W. SCOTT questioned the low-silicon content in these beds, the necessity for which had been stressed by Mr. Longden. It was understood that about 0.8 per cent. was the ideal to be aimed for. In Mr. Scott's opinion, an iron containing such a relatively low silicon would tend towards a white-iron fracture. He had experience in the class of castings concerned, although in fact they differed somewhat in design from that depicted by Mr. Longden, which had only one important face, whereas those to which he referred now had two faces opposite to each other, each of equal importance. He and his colleagues had at first looked upon these beds as they would upon ordinary castings, but they soon realised that they required special attention. Initially they had attempted to cast them clean in the horizontal position, but eventually came to what would appear to be the correct conclusion, that they must be cast in the vertical position. The section of these was $\frac{3}{4}$ in. to $\frac{7}{8}$ in., and it was this fact that led him to conclude that a low silicon would result in too hard a casting.

MR. LONGDEN, in reply, was able to quote an actual instance of low-silicon content in a casting of this type, the analysis of which he had had taken that week. The greater part of the bed was $\frac{7}{8}$-in. section, and the silicon was 0.82 per cent. It was his opinion that there existed a little fear of results with low silicon, and whilst he realised that there was a tendency towards white iron, he felt that a casting was not satisfactory that did not give a white-iron flash. The design of casting to which Mr. Scott referred was known to him, and he also had found it necessary to cast these on end.

MR. C. GRESTY expressed the opinion that the low silicon was probably caused by the extreme narrowness of the core; in other words, the sand would become extremely hot, surrounded as it was by metal, and would therefore give the equivalent result that one would expect if the casting was at least double the thickness. Continuing, Mr. Gresty remarked that they had not been told much about the machine that pulled the clothes to bits—the rollers with the gills on. Were they actually used to cut the clothes to shreds, or were they, as he suspected, covered before going into the machine? Another point on which he would like to be enlightened was the manner in which the chills were removed. There were a large number, and apparently they all had to come out of the small holes at the end. Were they all removed? There was also the question of corrosion. Was there anything special about the inner brass shell?

Mr. Longden stated that probably the laundryman's greatest problem was the removal of surplus water, and the rollers to which his questioner referred, had a steel sheath forced on over the gills. This in turn was wound with felt and cloth, and the surplus water passed through to the gills and so out. He was unable to say whether the chills were all taken out of the casting, but suspected they were not.

The question of corrosion depended largely upon the usage of the machine. The cast iron outer ends had a brass sheath inserted, and for ordinary washing, in which ordinary bleaching solution and common soap were used, there was no serious corrosion. In fact, for much work, no brass ends were used. The inner shell was brass, and polished. This stood up to ordinary washing extremely well, and machines which had been in service for over 20 years had these inner shells as bright as the proverbial new pin. Special purpose machines, he thought, were made almost entirely in monel metal, except the outside ends, which were of cast iron, and in those cases where strong corrosive action could be expected, the cast iron outer shell which came in contact with the corrosive liquid had a monel metal shield placed on it for protection.

MR. ROBSON expressed surprise that a very small amount of sag, or deflection, in the bed was vital. He could see no reason for such great accuracy as the lecturer said was demanded in laundry machines. He would also like to know the temperature at which the cores were dried.

Mr. Longden pointed out that, actually, accuracy and as little deflection as possible made a big difference. The pressure on a roller was exerted at the ends, and a difference of a few thousandths of an inch could make a big difference to the finish of the laundered goods, and it was finish that a laundryman wanted. Regarding cores and core drying, he held that in the case of an oil-sand core, one could not afford to get above 205 deg. C., but he preferred to keep to about 175 deg. C.

In further reply to Mr. Robson as to whether it was practicable to do the job all in oil sand, which Mr. Robson thought would eliminate the risk of scabbing, Mr. Longden stated that it would be uneconomical, and there would also be the problem of mould drying.

This closed the discussion, and the Chairman, after thanking all present for their interest, called upon Mr. Gresty to pass a vote of thanks to the lecturer, Mr. J. Longden.

Bells and Cannon

By J. R. NICHOLS

Bells and cannon—the one symbolic of the Church, the other of things martial—seem at first thought to be far removed one from the other, as indeed they are; yet in several ways they are linked together.

In the far-off days of bronze cannon, bellfounders often turned their attention and professional ability to the casting of cannon: for example, Robert Mot, who established the famous Whitechapel Bellfoundry round about 1570, also cast cannon for Queen Elizabeth's ships of war at the time of the Armada.

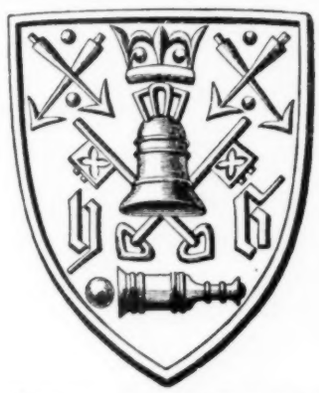
The foundry mark of a bellfounder of Bury St. Edmunds (of possibly early fifteenth century days) includes a cannon, indicating his activities in this direction, and Matthew Bagley, who came from the 17th century bellfoundry of Chacombe, in Northamptonshire, was killed in London in 1716 in an explosion that occurred while casting a cannon. In the reign of Henry VIII the exportation of bell metal became a criminal offence, there being at that time enormous quantities of bell metal for disposal, following the dissolution of the monasteries and the confiscation of their bells. An Act was passed to the effect that—

> "Noe p'son or p'sons shoulde from thenceforthe carrye or convey any brasse, copper, laten, bell mettall, gunemettall ne shroffe metal into anye part or parts beyonde the sea, upon payne of forfeyture of the said metall."

Although passed in the reign of Henry VIII, these Acts were not repealed until the reign of George III, but several petitions to export such metal were made, and generally these were granted: in 1582, however, one, Corsini, was prosecuted for the illegal exportation of bell metal from London. Bell metal and gunmetal being not greatly dissimilar, doubtless the object of these laws was to prevent the metal falling into the hands of unfriendly foreigners, perhaps to be converted into pieces of ordnance likely enough to be used against us.

In time of war in past days it was an old expedient to use church bells for munitions, and during the French Revolution this was the fate of the great bell of Rouen Cathedral, "George d'Amboise," of 19 tons weight, together with many other French bells.

During the European war, the Austrian Government consigned to the melting pot the great bell of St. Etienne, Vienna. This, strangely enough, was cast in 1711 at the command of the Emperor Joseph from the metal of



MARK USED BY BURY FOUNDERS.

cannon captured from the Turks, and weighed 17 tons 14 cwts. The "Kaiserglocke" of Cologne Cathedral, which weighs over 25 tons, was made from 20 guns taken from the French in the Franco-German war, though 4 tons of tin were added to make the alloy of the right proportions. In England there is at Liversedge, Yorks, a complete "ring" of bells that was cast from cannon, as is shown by the inscription on one of them:—

> THESE EIGHT BELLS WERE CAST IN 1814, AND 1815 WITH BRASS ORDNANCE TAKEN AT GENOA.

During the Great War the Germans removed many bells from the churches in South Jutland, and to replace them in 1925 an order was placed for 44 bells to be cast from the metal of 60 old brass cannon supplied by the Copenhagen arsenal.

At Roverto, Italy, is a bell known as the "Death Bell," and this was cast from metal from the guns of all nations who participated in the Great War; it is rung nightly, in honour of the dead.

Doubtless many other instances of bells being converted into cannon, and *vice versa*, could be traced.

TWO IMPORTANT EXTENSION SCHEMES in the Huddersfield district, indicating return of prosperity to the engineering industry in that area, are at the works of J. Blakeborough & Sons, Limited, industrial-valve specialists, of Brighouse, and Wm. Whiteley & Sons, Limited, textile-machinery makers, Prospect Works, Lockwood. Work on both is now in progress. The Blakeborough scheme will add 18,500 sq. ft. of floor space to premises already covering 13 acres. The firm now employ 800 men, and the extensions will afford facilities for more. The Whiteley extension will add 15,600 sq. ft., thereby doubling the premises and adding work for an extra 100 men. This firm began over 60 years ago. They went into liquidation in 1930, and two years later were taken over by Mr. Joe Charlesworth and his son, Mr. Hildred Charlesworth, and reconstituted.

Enabling Bill for Promoting Industrial Reorganisation

OUTLINE OF THE PROPOSALS

On Friday, November 23, Lord Melchett presented in the House of Lords a Bill entitled "Industrial Reorganisation (Enabling)." According to the Memorandum accompanying the Bill—which, it should be noted, does not affect agriculture, electricity or coal—its object is to provide for the self-government of industries by enabling the majority of producers in an industry, notwithstanding the opposition of a small minority, to introduce and cause to be enforced schemes for the reorganisation of the whole or part of that industry with the general object of promoting greater efficiency, eliminating wasteful competition, and of facilitating the production, manufacture and supply of the products of that industry.

As regard procedure under the Bill, any person or association of persons having an ownership interest in an industry may submit a scheme to the Board of Trade, and if in the opinion of the Board of Trade the interest of those putting forward the scheme is a substantial one, it is to be submitted to the National Industrial Council, which is to consider the scheme, and any objections and representations in relation to it, subsequently presenting a Draft Report to the Minister.

The Draft Report must contain the opinion of the Council as to whether (*a*) the application of such scheme to the industry to which the scheme relates is in the public interest; (*b*) the industry to which the scheme relates is a fit one for independent reorganisation; (*c*) the scheme provides for adequate consultation with persons having a special interest in the industry to which the scheme relates; (*d*) the scheme can be carried out without detriment to other industries; (*e*) the scheme contains proper provisions and safeguards for the future development or expansion of the industry to which the scheme relates.

The Draft Report is to be published and in certain cases an inquiry held after representations have been received. Two months after the publication of the Draft Report, or as soon as may be after the holding of the inquiry, the Council must prepare a final report, and submit it to the Minister, and if this Report recommends that the scheme should be proceeded with, it must be accompanied by a Supplementary Report dealing with the manner in which a register for the purpose of taking a poll of the industry and allocating votes should be established. Schemes will only be imposed when upon a poll being taken there is a majority in favour of three-quarters or more of the votes recorded. In the event of a successful poll, the scheme will be embodied in a Draft Order, drawn up by the Board of Trade, and this Draft Order must include provisions for the administration of the scheme, for the protection of minorities, for protecting the exploitation of new patents and processes and for the investigation of complaints. These provisions are included in Clause 11 of the Bill, which runs as follows:—

If the Board of Trade shall under the provisions of the last preceding section draw up a Draft Order embodying the terms of a scheme, such Order shall if the scheme shall not make provisions satisfactory to the Board of Trade provide for the following matters:—

(1) for establishing a body to administer the scheme embodied in the Draft Order and providing for the expenses of such body and remuneration to the members thereof;

(2) for imposing suitable penalties for the contravention of all or any of the provisions of the Draft Order;

(3) for the constitution from time to time of a committee of investigation charged with the duty of investigating any complaint made with respect to the operation of the scheme (other than complaints which could be referred to arbitration by the complainant under the provisions of the scheme) and for the manner in which the representation of such committee in respect of any such investigation shall be carried into effect in the event of the Board of Trade being satisfied upon such representation that any provision of the scheme is contrary to the public interest or unfair or inequitable in its operation;

(4) for ensuring that subject to such terms and conditions as the Council may determine, any new and improved process of manufacture of the products of the industry to which the scheme relates may be carried on without contravening the provisions of the scheme;

(5) for enabling contracts entered into before scheme comes into effect for sale or supply of the products of the industry to which the scheme relates to be performed without contravention of the scheme;

(6) for the keeping and amendment from time to time of the completed register relating to the industry to which the scheme relates;

(7) for requiring returns, statistics and other information with respect to the operation of the scheme to be furnished to the Board of Trade;

(8) for dealing with any other matters which, in the opinion of the Board of Trade, are necessary for carrying into effect the scheme embodied in the Draft Order.

The Bill contains provisions for the amendment or extension of schemes for penalties for false information and for penalties for the disclosing of information.

Schedule

A schedule of the industries to which the Bill applies is appended.

Mining and Quarrying Industry: Including the winning of limestone, granite, chalk, slate, stone, sand, natural rock, asphalte, gypsum, ironstone, fireclay (including china clay), salt, tin.

Iron and Steel Industry: Producing or manufacturing of pig-iron and all cast, rolled, drawn or forged articles consisting wholly or mainly of iron or steel.

Shipbuilding and Constructional-Steel Industry: Constructing with any of the products of the iron and steel industry any of the following products:—Ships, bridges, boilers, gasholders.

Non-Ferrous Industry: Manufacturing cast, rolled, drawn or forged articles consisting wholly or mainly of copper, brass, zinc, aluminium, lead, antimony or tin or any other non-ferrous metal.

Chemical Industry: Articles or things produced or manufactured by a process wholly or mainly consisting of chemical action, reaction or combination and not the product of any other industry to which this Act applies.

Mechanical Engineering Industry: Production of articles and things (other than the products of the shipbuilding and constructional-steel industry) made wholly or mainly by the machining, fitting or otherwise working upon any of the products of the iron and steel industry or the non-ferrous industry.

Other industries included are: Glass and clay products industry; wood-working industry; leather industry; rubber and asbestos industry; paper industry; oils and fats industry.

As a result of recent private conversations, a dinner was held in London last week, when a body, to be known as the Industrial Organisation League, was launched. Some 50 industrialists and others interested in the foregoing Enabling Bill were present. Mr. H. Macmillan, M.P., presided. Sir Robert Horne, M.P., in the course of some remarks, urged that a new type of industrial organisation was required. Recalcitrant minorities in many industries, he said, were holding back development.

THE COLTON ELECTRICAL EQUIPMENT COMPANY announce that their premises at 12, Moor Lane, London, E.C.2, and 12, Hamilton Road, N.5, have been closed. All communications should now be sent direct to Aetna Works, Elwood Street, Highbury, London, N.5.

Industrial Lighting in Sheffield Foundries and Steelworks

A Paper, entitled "Industrial Lighting: Some Problems in Sheffield and their Solution," was read by MR. R. W. DANIEL, B.Sc. (H.M. Inspector of Factories), before the Illuminating Engineering Society in London recently.

The author stated that the general lighting observed in Sheffield steelworks is of a higher standard than that encountered in other local industries, and general working intensities sometimes exceed those provided for much finer work elsewhere. Local lighting, where provided is, however, frequently poor and glaring. Adequate maintenance is also much neglected, largely, it would appear, on account of the height and inaccessibility of the general units employed; increasing loss then becomes inevitable. One example, a rolling mill, is of particular interest. Two sets of rod and bar rolls are centrally driven. Both sets are structurally similar, and both sets were originally lit by the same number of similarly placed old 300-watt lamps in discoloured shallow reflectors. The mean working intensity on both floors was 4½ foot-candles. By replacing similarly situated test points, comprising 150-watt lamps, one-half the original capacity, in modern reflectors experimentally over one side, the average reading was increased to 6 foot-candles. The mill with two other associate mills was thereupon re-lit.

With the general trade recovery certain other mills are rapidly completing modern installations of a high standard. In one, the mill floor is lit to an intensity of 8 foot-candles by large new gaseous discharge units, controlled through relays by photo-electric cells. By a dual circuit, twilight and darkness automatically switches on the lighting in two stages. In another instance, a large rolling mill has been relit by improved high-pressure gas units, with excellent results. Many smaller mills and forges have, however, been slow to follow the lead of their larger neighbours. Steel forging is still largely an ill-lit industry, 0.3 foot-candle, and even less, being not uncommon. Maintenance is much neglected, and in one instance dust had reduced the light from a modern installation by 66 per cent. throughout.

Among the steelworks a light-operated safety signal device, recently instituted, is of particular interest. A busy length of permanent way, passing several workroom doorways, was floodlit from the out-running end. At the other, a photo-electric cell was coupled to a relay. Intrusion of a locomotive, or other vehicle, into the light beam, thus caused red danger signals to glow in all doorways opening to the track.

The tradition that hot metal needs no light dies hard, and both forges and foundries still adhere largely to this belief. The value of good lighting in the taking of accurate measurements, and in the careful moulding among dark sand, is overlooked. Most Sheffield foundries are but dimly lit. Of those in which photometric readings were taken, only 10 per cent. showed mean working intensities in excess of 5 foot-candles. Twenty-three per cent. showed less than ½ foot-candle, and 71 per cent. less than 2. Under such conditions small moulding irregularities are most difficult to detect. Yet in only five foundries was the lighting consumption estimated to be insufficient to have provided adequate illumination if correctly used. Further, in seven cases the reasonably adequate lighting provided was practically halved in value by accumulated grime. A quick dusting of the best unit found in this industry gave an instantaneous rise in floor intensity beneath it of from 7 to 12 foot-candles.

In the smaller ill-lit foundries, low, totally unscreened, points are often encountered. Against the dark background, the glare is severe, and with molten metal in frequent use may increase

(*Concluded on page* 364)

Practical Sand Control

THE DESIRABILITY OF SPECIFICATIONAL CONTROL

After Mr. Walker's Paper* on "Sand Control," read before the Sheffield Branch of the Institute of British Foundrymen, an excellent discussion ensued, which was opened by MR. N. D. RIDSDALE, who, after conveying greetings from the Middlesbrough Branch, referred to the questionnaire that had been sent out by the Sands Sub-Committee. One of the objects in forming the organisation was to encourage founders to make contact with each other. Great benefit was to be derived from the co-operative study of foundry problems. A questionnaire was often liable to be regarded with suspicion at first, but he hoped that this questionnaire would be accepted in the spirit in which it was evolved and would really be found useful to foundrymen in different parts of the country. They had therefore arranged for the questionnaire to be issued through the different branches. It was hoped in that way to get useful information from all over the country in the course of the present session.

Necessity for Familiarisation with Figures

The sand tests would enable founders to grasp what the different figures meant. Until they had had some contact with the tests a permeability number of, say, 50 did not mean very much to them, but when they had really associated it with a certain sand with which they were familiar it would have some definite notion, and they would begin to see how the tests were valuable. They had already heard from Mr. Walker the standard tests which the Sub-Committee had recommended for acceptance throughout the country and, of course, he had already made it clear that those standard tests and standard equipment applied to *routine* tests. He was not sure if Mr. Walker had made it quite so clear that the idea of the tests was that they could be used in any foundry. They were simple, easily-made tests which could be applied by an apprentice moulder, or anyone else who was not provided with a chemical laboratory. He was sure that the feeling was shared by all that they wanted to get interested in the subject of sand testing, and any mere discussion as to precise dimensions of test-pieces, or precise details of apparatus, was relatively a secondary matter. There were sure to be members who would feel that for special purposes and researches they would need to use different or additional methods of testing sands. Moreover, some people would have their own ideas about apparatus and methods of routine testing, but the main object was to get simple standard tests which could answer for all ordinary purposes. To his knowledge, during the last year or two, 25 to 30 firms in the country were equipped with the standard apparatus recommended by the Sub-Committee. They were using it regularly, and, he believed, they were quite satisfied with it. At the present time the Sub-Committee was largely engaged in dealing with tests and queries arising out of the questionnaire, but they were also dealing with the subject of dry-sand and core-sand tests in addition to green-sand work. They were also dealing with the question of mould-hardness testing. Those things were keeping their hands fairly full at present. He hoped that the questionnaire would be made use of in the Sheffield Branch and that the founders would come forward and supply the necessary samples for Mr. Walker to make the tests.

Skin of Casting the First Consideration

DR. J. G. A. SKERL, referring to the lecturer's remarks on permeability, stated that according to the modern trend of thought permeability should be subordinated to the claims of a better finish on castings. In American practice, especially with regard to synthetic sands, the addition of a fine grained material like silica flour had been advocated in order to improve the finish on castings. The addition of the silica flour to the facing sand definitely lowered its permeability, but nevertheless the surface of the castings was improved. Care was taken, however, that the backing sand had a permeability greater than the facing sand and therefore did not contain the silica flour.

The percentage of bonding material or clay in a moulding sand had some influence on the refractoriness of the material, but it was not so great as generally imagined, especially nowadays when the tendency was to use less heavily bonded facing sands due to more efficient sand treatment plants and the greater use of moulding machines.

Ramming Densities

The lecturer in his short survey of testing methods had omitted one which was of the greatest importance, especially in its practical implications. The American methods of testing sand at one particular ramming density, by dropping a weight three times on a sample of sand (greater or less number of blows yielding an unevenly rammed test-piece), was suitable for purely routine testing, but ignored the fact that one of the secrets of the moulder's art was the necessary variation in ramming for different jobs in different sands in different foundries. The sand should be tested as far as possible in the condition as it is used on a particular job, and the variable which was most important was the degree to which the sand had been rammed. The method, known as the double-compression method of preparing a test core to any suitable degree of ramming, brought forward by Mr. W. J. Buchanan, one of the members of the I.B.F. Sands Committee, was most important, and had been adopted by the British Cast Iron Research Association (Special Report No. 2, 1934), and allowed the use of the same core for both strength and permeability testing.

Specifications May Create Difficulties

The question of specifications for moulding sands was one upon which a cautious attitude should be adopted, since published data from one particular foundry in an area may be misleading to other foundries in other districts, using the same or different sands, or using different methods of moulding. Full disclosure of all the details of the sands and their methods of use was essential if full benefit is to result from the publication or study of such data. The results given by Mr. Walker yielded green strength data, but of great importance to the steel founder was the strength at higher temperatures in view of the great cutting action of molten steel. Unfortunately there was no definite relation between the green and dried strength of a moulding sand, and this relation was a vital property of each sand.

Local Considerations

The lecturer's figures would doubtless be tried out by other steel founders all over the country. Difficulty would arise since the figures were based on certain sands which were probably the cheapest in Sheffield, but which would be much dearer in other districts. The sands used in the other districts would have different properties, but they give satisfactory results in the form of moulds. The position was that many more Papers by steel founders on the properties of their moulding sands were required, and only then will it be possible to give adequate specifications containing upper and lower limits for the properties of different sand for different jobs under varying conditions. The present Paper only gave certain specifications for certain conditions, but was a start in the right direction.

Mr. Ridsdale had remarked that there were over 25 sets of A.F.A. sand testing equipment in this country. There were approximately 100 sets of the B.C.I.R.A. sand testing apparatus spread over this country and abroad which could be used for testing the sand according to the methods advocated by the B.C.I.R.A., and could be adapted for testing the A.F.A. test-pieces. The B.C.I.R.A. were co-operating with the I.B.F. Sands Committee, and he hoped that the questionnaire which had been prepared would be universally answered.

Worth of Various Tests

MR. WALKER, replying to Dr. Skerl, said he quite agreed that it was a common practice, not only in America, but also in England, to treat the surface of the mould with white or black silica paint, which certainly gave a thin superficial layer of very low permeability. In some cases this appeared to improve the surface of the casting, but in other cases it did not appear to have any particular effect. He did not think he had omitted the consideration of ramming density in his Paper. He had also referred to the fact that the B.C.I.R.A. apparatus allowed a specimen to be made of any desired density. It was also possible, when using the A.F.A. specimen, to ram to any density, if the standard ramming apparatus were not used. He agreed that ramming density was important, and must be stated in the record of the test, otherwise the test was useless. He did not specifically mention the double compression method mentioned in his Paper, but agreed that it was a good method; there were also other good methods in use, which were described in detail in the report of the Sands and Refractories Sub-Committee referred to in the Paper.

The Time Factor

With regard to the specifications outlined in the Paper, he agreed that it was probable that they would not be of general application in their present state, but he thought it was time they began thinking about specifications so that in time some could be made that would be of general application. If they never started, they would never get anywhere. It was true that other foundries used different sands from those in the foundries with which he was connected, but some of the sands referred to in the Paper were used all over this country, and many of the sands used in different parts of the country had very similar properties. He had actually tested from this point of view sands from England, France, Belgium, America and Australia, and it was surprising to find how generally similar many of them were, and how closely they could be made to give similar mixtures by modifications in the method of treatment. He agreed that the specifications were by no means exhaustive, and this was stated in the Paper. They were simply typical specifications of selected sands, and it was hoped that by future efforts they would be elaborated and made of general application.

Hardness Tests

MR. RIDSDALE said he had found the moulding hardness test to be of considerable value, particularly in regard to mechanically-squeezed or prepared moulds. Thus, if they rammed a hand specimen, they might find a mould hardness of 70, but in the case of a hydraulically-squeezed mould, they might find it to be, say, 50. Of course, they did not know what the relationship was between one and another.

Control of Natural Sands

MR. J. ROXBURGH said that the knowledge gained by the carrying out of the tests indicated by Mr. Walker was really of great use to the foundryman in many respects, but he felt that what was of the greatest importance of all was the application of such knowledge to their foundry practice. He (Mr. Roxburgh), in the course of the lecture, had looked forward

* FOUNDRY TRADE JOURNAL, November 15, 1934, page 305, *et seq.*

XUM

with interest to Mr. Walker's tentative specifications for the moulding sands. In regard to the specifications for synthetic sands, he felt that there was definitely a chance of the supplier being able to work to the limits specified, but, after all was said and done, when they were talking about raw sand, it was quite a different matter, as the sand was quarried in its natural state and varying properties could be expected. Speaking from his own experience of moulding sands for ironfounding, he felt that the supplier would have great difficulty indeed in complying with the specification as outlined by Mr. Walker. The trend in the iron foundry to-day, particularly in the repetition foundries, was definitely in the direction of synthetic sands. It would be agreed that such sands lent themselves to control, but he felt that, from experience of the natural sands they received into their own foundry, when one talked about grain size, moisture, bond strength, etc., the sands supplied were very far from the ideal in regard to lending themselves to control. He agreed with Dr. Skerl that the question of the ramming of the sands was a very important one indeed, and that the density of ramming in these tests, mentioned by Mr. Walker, should be varied as much as possible.

The Moulder's Technique

The technique of the moulder was wrapped up in the question of the different densities of ramming. He felt that that aspect of the matter could not be stressed too much. Mr. Walker specified some compositions, mechanical properties, etc., for sands to be used for castings of a certain weight, and he wondered whether it might not be useful to include in that specification, too, the sections of the metal. If one took oil sand, for instance, one knew that, with a certain section of metal, the oil sand was insufficiently refractory, and he felt that that was rather an important point which should therefore be included in a specification. For his own benefit he would be interested if Mr. Walker would indicate to him a suitable sand that was used in a steel foundry for the moulding of some particularly large casting. He himself had been responsible for the manufacture of a large cast-iron anvil block, and he wondered if Mr. Walker would inform him of a suitable type of sand for such a large casting made in steel.

Creating Internal Standards

MR. WALKER said he thought he had made it fairly clear that with regard to raw moulding sands, they could have a series of such sands which would all be satisfactory to the foundry when mixed with different silica sands, the proportion of silica sand naturally depending upon the raw material with which they started. In this respect it was clear that they could not possibly have any single specification covering all the raw sands in the country. If, however, they were using a particular kind of raw sand obtained from a particular bed, it would be a comparatively easy matter to test the raw sand as they received it, and find out which consignments gave satisfactory results and which did not. They could then base their specification on the properties of the satisfactory consignments, and ask the suppliers to supply sand only to that specification.

It was true that such a specification would not be applicable all over the country, but it would certainly be of considerable value to the particular foundry concerned, and could no doubt be easily extended to other foundries, using the same sand, and doing similar work. With regard to the weights of castings mentioned in the Paper, he had indicated the weights as showing the type of work for which the sands were intended, the weight of castings being such a commonly quoted figure, but actually it was the section of the metal which was important. When he referred to a casting weighing a few ounces or a pound or two, it was clear that it could not have a very heavy section, but he did not think that he could give precise values for the actual thickness of section, since the actual disposition of the different thicknesses in a casting altered the effect on the sand during the casting operation. Regarding very large steel castings, he was afraid that he could not give specifications for sands to be used for these. In their foundry they followed the usual Sheffield custom and made castings of many tons weight in "compo."

Cost of Local and Remote Sands

MR. F. E. STEELE said Dr. Skerl had mentioned the fact that owing to various districts having different qualities of sand there would be considerable difficulty experienced in setting any one specification as being standard. That, to his mind, was one of the difficulties that founders were up against constantly. No doubt most of them would like to use on special jobs sand that they were not able to use owing to the high cost of the delivery of that sand to their particular district. In his own case he recalled an instance where they were recommended for a special job to get a sand that was admittedly well known as a good sand, but the price for delivery to his district was prohibitive. They accordingly experimented, and he was glad to say that they secured good results. He took it that Mr. Walker intended to convey that in Sheffield for similar classes of work they would use similar classes of sand.

Institution of Private Specification

MR. WALKER quite agreed that standard specifications of universal application could not be put forward at the moment, but what he was concerned about was the principle of making and using specifications for sand supplies. If Mr. Steele in his foundry established testing apparatus to examine the different sand mixtures he was using, he would be able to find what values of the tested properties gave him satisfactory results with his sand mixtures, and then would be able to make up a private specification to which he could work in his own foundry. He could then test the different batches of sand he made in the foundry, to see if they were satisfactory before going on to the foundry floor. The result of testing his mixtures would, however, depend on the properties of the raw sands he was using, so that he would next have to examine the raw sands, find what their properties were, and see whether the consignments were uniform as they came in.

The Lead of the Mechanised Foundry

MR. WHARTON said that the reason the iron-founder lagged behind in the testing of sands was because his product was not so costly as steel, and he did not examine his waste as carefully as the steelfounder did. He was sorry, though, that he had not said a little more about the amount of water that might be found in some of the consignments of sand he had received, and also a little more about the importance of the moisture content of the sand on the shop floor. Those who had been associated with mechanised foundries would already have recognised the importance of the control of sand, and the beginning of that control was the testing for moisture content. That had an important effect on the properties, such as permeability and strength. Then there was the question of specification. As Mr. Walker had said, that was a local matter, but it was a very necessary one. Mr. Walker would probably find it more difficult when he had to make a specification for some of the clays for the bonding of his sands. That was a point they would come to probably in the near future. Some of the tests Mr. Walker had done were not exactly suitable for shop work, but they gave a great deal of information for use when buying new sands. He thought that, when they had had time to consider the figures, which no doubt would appear in THE FOUNDRY TRADE JOURNAL, they would more thoroughly appreciate the work that Mr. Walker had put into his Paper.

Moisture Content

MR. WALKER agreed that the moisture content of sands was very important, especially in consignments of sands as received. Sometimes it happened that sand was loaded into wagons and delivered to the foundry in a very wet state, the water increasing the cost of the sand. It was the general practice to convey sands mixed ready for use in covered wagons, but he had seen them sent in open wagons, and in such cases the moisture content sometimes rose to a very high figure. In the case of silica sands, after being received, they ought to be dried, so that the people in the foundry knew how they stood before adding any water. In the case of batches of sand mixed in the foundry, he agreed that it was most important, especially with green-sand mixtures, to test individual batches, and the easiest thing to arrange in practice was to have a boy somewhere near the mill, so that as each batch was mixed, he could test it on the spot. This, with a "Speedy" moisture tester, would not take more than 5 min. If it was satisfactory, the sand could be sent into the foundry, if it were not, it could be corrected before use.

He agreed that constructing specifications for clay would be more difficult than for foundry sands. It could not, of course, be done from chemical analysis alone. In his view, however, specifications could be constructed by using a known weight of a particular clay, mixing it with a specified amount of a standard silica sand, and finding the properties of the resulting mixture. The difficulty at present was that there was no such thing as a standard silica sand. If such a standard silica sand could be prepared, it would be useful in many ways, but its actual preparation was by no means an easy matter.

Vote of Thanks

MR. S. LEETCH proposed a vote of thanks to Mr. Walker. He said he was sure that Mr. Walker would not say that they could run their foundries from the laboratory. At his (Mr. Leetch's) own foundry they had solved a difficult problem in getting a good skin on small stainless castings by using the methods that Mr. Walker had expounded that evening and with the good offices of Mr. Hurst. They were doing a great deal of research work, and there was room for a great deal more, but it would have to be the handmaiden of the practical man who had had years of experience and had learnt by his mistakes.

MR. GODDARD seconded, and expressed the opinion that steel founders ought to work from a dry base and then they would be able to control their own moisture.

The vote of thanks was carried, and in reply MR. WALKER said that whilst he fully agreed with the remarks of Mr. Leetch that some old moulders dealing with the same sand mixtures year after year could tell as the result of very long experience whether a sand mixture was satisfactory or not by inspection and feel, it was a fact that such practical men of great skill were becoming rarer and rarer. The actual workers in the foundry would in the future have to be supplied with more and more technical assistance from the laboratory. It was a regrettable fact that owing to the modern trend to mechanisation and for various other reasons, the number of craftsmen of the old high standard was steadily diminishing.

[We are rather surprised that no comment was made during the discussion, that firms instituting specificational control would obviously receive consignments of a more regular character than those not so organised.—Editor.]

At the close of the discussion the President presented Mr. J. Roxburgh with a diploma awarded by the Institute for his Paper on "Alloys in the Iron Foundry," read to the branch earlier in the year.

The PRESIDENT complimented Mr. Roxburgh on the honour, observing that it was some years since a diploma had come to the branch.

Elucidating Foundry Problems

SAND CONSUMPTION ESTABLISHED

A discussion upon foundry problems was carried on by various members of the Lancashire Branch after hearing Mr. Cook's presidential address.*

Core Barrels for Beetle Bowls

MR. A. SUTCLIFFE (Bolton) referred to problems in connection with trunk castings and beetle bowls, 20 ft. long, cast from the end. No trouble was experienced so long as the boxes were perforated and the gases were allowed to rise up.

MR. J. HOGG (Burnley) said that the illustration of the beetle bowl was extremely interesting. He was concerned with the making of such bowls, there being a boss at either end, 12 or 15 in. in depth, and the main core would be about 18 in. He used to have a core barrel of about 4 in. diameter, which was of cast iron, and rings were used for wedging purposes. The coremaker used to get a bundle of hay and have a boy turning hay bands, which were pressed on by means of a 56-lb. weight. These beetle barrels were made very successfully, until eventually the question arose of the coremaker sitting down at his ease whilst the boy spun the hay bands. It was decided that too much time was lost thereby. The firm decided to buy straw ropes to be used instead of the hay bands. The result was that there were six waster beetle rolls as a result. He had never been able to find a satisfactory explanation for this occurrence. When the firm reverted to the hay bands, successful castings were again obtained.

MR. SUTCLIFFE said that he would not use straw rope on the casting. If the bottom ring was wedged up in the proper manner, it would be safe enough. If Mr. Hogg had used cotton ropes, he would have had greater success.

MR. A. L. KEY (Stockport) thought that the relative merits of hay bands and straw ropes did not enter into the question at all. When he was first engaged upon such work he had no straw ropes. In making a loam core that was to withstand pressure 20 ft. deep, for every pound there was 20-ft. static pressure. The fundamental point was as to how the rope was incorporated. The correct way to band a barrel for such a job was to have an equal space between the bands, according to the diameter of the band; if a 1½-in. band was used, there should be 1½ in. in between the strands. The loam should be squeezed in by weighting. For an 18-in. core he would probably put about 2½ in. on the first coat and vent it and dry it. He would then put on more straw, and probably only one coat would open. There would then be a bridge of loam carrying the next bridge of loam. Speaking of depths, he once received an order for the making of a number of hydraulic rams, weighing up to 9 tons each, 3½ in. diameter, 14½ in. thick, and with a metal bottom. Incidentally, the hole in the top of the ram was 13 in. He had a 24-in. core to make on an 11½-in. barrel. The same method was pursued. He fastened up with a series of rings, but between each ring, although it was wedged on the barrel, there was an iron strut to prevent the pressure from the bottom, forcing it upwards. From the top to the bottom ring there was a ½-in. iron clamp made, so that, when the core was turned on its end, there was no fear of the core sinking down. The band was thoroughly dried and made with clay, black sand, and any straw waste available. The castings had to be to a guaranteed definite weight. The core was made ⅞ in. larger than the size of hole required. From ⅞ in. upwards to 2¾ in. was the largest he ever had. Even with that precaution it would be realised what might be expected with a 6-in. coat. Unless there was a coating between the bands on the barrel forward, trouble must be expected.

Defects in Bronze Gear Tooth Wheels

MR. F. DUNLEAVY (Bolton) referred to a problem in connection with a bronze gear-tooth wheel. A tooth had been sawn off the gear, and behind the tooth would be observed what he considered to be the effect of gas. The firm with which he was associated were commencing to execute a big order. Was it possible, when using an oil furnace that was blowing oil on to the metal, to have that trouble in a tooth? A 3½-cwt. furnace was being used. If it was gas in the riser, why did it not show in the runner? The problem was not an everyday one, but something one met once in a lifetime.

A second problem mentioned by Mr. Dunleavy was that of a test-bar cast for hardness and giving a Brinell hardness of 92, and which appeared to give a very poor fracture. What tensile strength was to be expected from such a test-bar? Personally, he would expect 15 to 16 tons, but actually it was less than 10 tons. The casting was made with two runners and two risers and without a scab. Would casting green affect the grain size? He believed it was possible for copper to absorb gas from the flame.

THE BRANCH-PRESIDENT (Mr. W. N. Cook) said that with regard to the section cut in the riser it was what was called a burnt section. If the metal was remelted and cast again at the correct temperature there would be no brown marks in it. The brown marks in a phosphor-bronze were the function of the temperature of the casting. Apparently, the casting had been too hot.

MR. DUNLEAVY: It was cast at 1,060 deg. C.

THE BRANCH-PRESIDENT said he should have thought it was about 1,180 deg. C.

MR. A. PHILLIPS (Manchester) said if Mr. Dunleavy cast three test-bars of the metal, one high, one medium, and one at a low temperature, he would probably obtain some interesting information. These when tested would give a good test figure and fracture for the high-temperature metal, the low temperature would give poor physical properties and a fracture showing the dark-brown segregation which is a characteristic of oxidised metal, with intermediate structure and physical tests for the medium temperature.

In the runner and riser of the case mentioned there are similar conditions to the high and low temperature of the test-pieces and also fractures are obtained which compare with the high- and low-temperature bars.

MR. A. L. KEY said that he could substantiate Mr. Phillips' remark. Some years ago he experienced the same trouble himself, and it took a couple of months to ascertain what was the cause of it. Experiments were made in collaboration with Mr. Jolly until absolutely perfect castings were obtained. It was ascertained that the casting temperature did not entirely solve the problem, because if the metal were oxidised it did not matter what the temperature was; there must be a re-melt. When the melting was under charcoal and flame was absent, there was no recurrence of the trouble.

MR. DUNLEAVY said that one furnace was used which was of the M.R.V. type, while the other was an oil furnace.

MR. J. JACKSON (Accrington) gave his opinion, from visual examination that this metal would have been better if remelted. Also, when casting such a job with one or two runners at one side of casting, and a riser at the opposite side, it was possibly inviting trouble. To cast this job, an outside ring runner, to rise from somewhere near the centre, would be better. From the appearance of the fracture, he would say, the metal had not been properly mixed.

MR. DUNLEAVY said the point was that he had cast hundreds of gears without experiencing the trouble.

THE BRANCH-PRESIDENT: Using an oil furnace?

MR. DUNLEAVY: Yes. We have had trouble occasionally. I want to know, before I start the job, what is the cause of the trouble. We have had gears without a blemish, though, of course, we have had wasters like everyone else.

MR. A. PHILLIPS said that without examining the specimen microscopically it would be difficult to express a definite opinion as to the cause of the trouble. Probably it would be advisable if Mr. Dunleavy's melting practice was satisfactory to examine the consignment of copper for oxygen; this was best ascertained by microscopical examination.

THE BRANCH-PRESIDENT: Once there is oxide in the metal it cannot be held except by remelting, unless an excess of phosphor-copper is used. Certain brands of best selected copper were remelted from scrap. He once bought a consignment of copper which turned out not to be virgin; he condemned it and bought virgin material.

MR. S. E. DAWSON said that the trouble might be due to melting conditions and suggested two possibilities—one, a deposition of carbon on to the cold charge from the oil fuel employed in the furnace and the other an excess of air supplied to the burner.

Without knowing the type of furnace and the conditions of operating the burners it was impossible to say which might be the cause of the difficulty.

In the first case the use of smaller charges or the successive additions of metal to reduce the bulk in the furnace would avoid contact with the flame and reduce carbon deposition and absorption into the metal and at the same time provide a larger combustion space with consequent increased efficiency of heat production.

In the second case, two or perhaps three trial runs with decreasing air supply to the burners would clearly indicate from test-bars taken as to whether oxidation was occurring, and permit a correct balance of air and fuel to be established. To ascertain such balance was important also from the fuel-consumption point of view.

If, as stated, a coke furnace was also available, a comparison of two melts, one from this and one from the oil-fired furnace, would do much to clear up the question of oxidation.

As an indication of the possibility of oxidation from this source, it is well known that the carbon in cast iron can be reduced by as much as 0.6 per cent. if melted with an unduly oxidising flame in an oil-fired furnace.

Unbalanced Tex-Rope Pulleys

MR. R. A. JONES (Pendleton) mentioned a problem in connection with a tex-rope pulley, upon which there were a series of grooves, ⅜ in. deep, and a screwed bore. There was 1⅝ in. metal round. The problem with the pulleys was that they must be perfectly balanced when they were machined, otherwise they would cause a little chatter on grinding wheels. The difficulty was to prevent segregation. If there was the slightest discoloration in machining, they were rejected.

A second problem was similar, namely, a tex-rope pulley which was solid, weighing about 1 qr. 12 lbs., and bored 1⅜-in. screw bore, and carrying a series of grooves. They were ordered in batches of twenties, and various ways had been tried of casting them. The only run in which they were got perfectly successfully was last December, when some old Doncaster No. 3 pig-iron, 1908, was used. There was no trouble

* FOUNDRY TRADE JOURNAL, November 1, 1934, page 271.

XUM

with that batch. They had been tried with a fine spray runner with risers on and chills in. He had tried running them with pencil runners, and sometimes it was a success and sometimes it was not. The pulleys must be perfectly balanced, and they were run at a high speed. It was not a matter of them being reasonably clean, because if there was a pinhole, they were rejected. By segregation one got a sort of pinhole somewhere, and it threw the whole out of balance. This occurred during contraction, when the metal was drawing away. The speed of running was about 1,000 r.p.m.

MR. S. E. DAWSON thought the trouble would be due to the metal used. By using a metal with either a short or a very long freezing range the trouble would be overcome. The shorter freezing range was perhaps better, since it would set almost immediately it had filled the mould. By lowering the carbon, say, by 0.1 or 0.2 per cent., a metal would be obtained which would set very much quicker, to give a more homogeneous structure. This could be obtained by either the addition of a little steel in the charge or the use of a low-carbon refined iron.

It would be interesting to know the analysis of the Doncaster pig-iron referred to which gave good results, and to what extent this agreed with the above suggested requirement as to structure.

MR. JONES said he had tried 20 per cent. steel with 2.6 silicon.

MR. S. E. DAWSON said that whatever metal was used, it must be in eutectic condition. He would say that the silicon was too high. Silicon of about 1.8 or 2 per cent. would be likely to give the desired result. What was required was a eutectic balance on the lines of Mr. F. J. Cook's formula. By keeping to such a balance, he thought there would be a minimum of surplus fluid components present.

MR. MCLACHLAN (Stockport) suggested feeding with a riser, 1¼ in. would be sufficient, and feeding in at the opposite end where the metal was duller.

MR. A. L. KEY said he had experience of similar trouble. He had cast blanks out of material which had a total carbon of 3 per cent. and silicon 1.1 per cent. He had cast them out of general ordinary metal, total carbon 3.5, silicon 2 per cent., with the same results. With regard to Mr. McLachlan's remark, he had used one riser and also two risers, and the segregation sometimes occurred in between where the risers were and sometimes underneath the risers.

MR. H. E. BEARDSHAW (Manchester) wished to substantiate Mr. Dawson's remarks and referred the members to certain of his (the speaker's) published Papers in which he had dealt with flywheels running at 1,500 revs. The only way in which he could overcome the difficulty was that suggested by Mr. Dawson, namely, control of the material, coupled with the manner in which the castings were run. They were run by two small runners in the rim, which were absolutely opposed to each other and the material set very rapidly. There would never be any success obtained by running from one side, because there was a different density on the side opposite to the runner to that which obtained with the runner. He should say the silicon should be of the order of 1.1 or 1.2 per cent. for the size of casting, and the carbon certainly not above 3.1 per cent.

MR. A. L. KEY said he had followed on the lines of Mr. Beardshaw's Paper, the total carbon being exactly 3 per cent. and the silicon 1.15 per cent., and still he had experienced the trouble.

MR. J. E. COOKE (Branch-Secretary), referring to the screwed bore, said that quite often the difficulty could be overcome by chambering out.

MR. JONES agreed, but it was necessary to have the straight core through and a screwed bore.

Quantity of Sand Used per 100 Tons of Castings

MR. J. E. COOKE (Branch-Secretary) submitted the following problem:—"Is it possible to state approximately the quantity of new sand per 100 tons of casting which should be required for: (*a*) medium-weight (7 cwts.) ordinary grey-iron castings in green-sand moulds in a jobbing foundry; (*b*) light castings produced in castings in quantities on moulding machines, in 14-in. by 14-in. boxes, and (*c*) textile-machinery castings requiring special finish for glazing?"

MR. A. L. KEY said it was possible to have job castings which would require twice as much facing sand as in other cases. A pattern which was flat could be dealt with by a minimum amount of facing sand. If, however, the pattern was built up, and pinnacles put upon it, the man would build it up to half cover the pattern. His own work was of a very miscellaneous character. From certain records he had obtained he found, taking the shop through, they averaged 22 per cent. of sand related to a ton of castings. None of the facing mixture contained more than 30 per cent. of new sand.

MR. J. E. COOKE (Branch-Secretary) said he questioned the company concerned with regard to the type of castings. Most of them were of the flat type, and not of a type with high projections and deep insides.

MR. J. JACKSON said that, generally speaking, among textile machinists the proportion was 30 tons of sand per 100 tons of castings. That figure was fairly common.

MR. S. E. DAWSON said that the figure of 30 tons coincided with a figure he had just worked out quickly. Whilst this would vary according to the class of work made, the amount of new sand required, taken as an average after the first start, would be 30 per cent. of the tonnage of metal produced.

MR. A. L. KEY inquired whether that included sea sand.

MR. S. E. DAWSON replied that it embraced all new sand.

The Casting Skin

The chemical composition of the skin of grey cast iron has been determined by E. Diepschlag.* In order to take off from the test-bar as thin a layer as possible, the bar was gripped in a lathe and treated with a file by passing it with equal strokes and uniform velocity over the whole length of the revolving bar. The metal powder thus obtained was gathered and the decrease in diameter of the bar accurately measured. The loss in weight of the file was always less than 0.1 per cent. of the metal powder obtained and could, therefore, be neglected. In this way samples were obtained from the outer layer of the bar about 0.0008 in. thick, then from the underlying layer about 0.004 in. thick, and finally a third sample was taken from the centre of the bar.

The chemical analysis was performed in the usual manner. Preliminary experiments carried out with three irons containing silicon 2, 2.5 and 3 per cent. respectively, which were cast in blacked and unblacked moulds, showed that the quantity of metal powder obtained from a bar 0.8 in. in dia. and 17.7 in. long was too small to carry out a complete analysis and avoid inaccuracies in the graphite and silicon determinations. Therefore, in a further experiment, the filings of three bars of the same melt were gathered and analysed. The mixture contained about 2 per cent. of silicon. The analytical results are recorded in Table I.

The figures given in column 9 represent the incombustible residue obtained in the graphite determination. The iron (column 10) was determined by analysis. In computing the sum (column 11), the silicon was always taken as 1.92 per cent., because higher figures are probably due to sand inclusions. The oxygen content (column 12) was found as remainder. From the figures given it is obvious that the cast iron undergoes a profound change in the outer layer of a casting. The carbon is probably consumed by oxidation during the casting process. The loss in carbon is higher in the unblacked moulds, that is, the blacking exerts a protecting effect against oxidation. The outer layers of the unblacked bars contained a considerable quantity of iron oxide. The high sulphur content in the skin of the blacked bars originates from the blacking, which contained 2.11 per cent. S. The high phosphorus content in the skin of the unblacked bars seems to point to the formation of exudations. As to the surface appearance it was found that the bars from the blacked moulds were much smoother and more uniform. However, when the skin of these bars had been taken off, a number of small holes and elongated grooves in the form of cold-shuts became visible, which were not found in the unblacked bars. The holes were caused by small sand particles which fell out during filing. These irregularities disappeared after removing the second layer.

TABLE I.—*Chemical Composition of Casting Skin.*

1. —	2 Thickness of layer.	3 T.C.	4 Gr.	5 Si.	6 Mn.	7 P.	8 S.	9 Sand.	10 Fe.	11 Total.	12 O.
Cast in blacked mould:	in.										
Layer 1	0.001	2.70	0.40	2.22	0.40	0.55	0.065	0.02	93.4	99.055	0.945
Layer 2	0.0048	3.12	1.85	1.92	0.45	0.71	0.032	0.15	93.6	99.982	0.018
Centre	—	3.90	3.13	1.92	0.40	0.66	0.024	—	—	—	—
Cast in unblacked mould:											
Layer 1	0.0008	2.15	0.81	7.86	0.34	1.38	0.032	1.07	77.6	94.122	5.878
Layer 2	0.004	3.25	1.50	2.37	0.40	0.58	0.032	1.60	89.6	97.382	2.618
Centre	—	3.92	2.33	1.92	0.40	0.63	0.025	—	—	—	—

* "Die Giesserei," 1934, Nos. 39-40.

Continental Steel Cartel

It is expected that this month there will be an advance in international steel prices, particularly in Scandinavia, the Cartel already having fixed advances for Norway and Denmark from next January. The maintenance and advance of prices in certain countries are considered imperative to enable British competition in the Far East and India to be met. The Cartel considers that trade with India is slack as Indian importers are awaiting the issue of the Cartel's new schedule of prices. The Cartel members also believe that at the moment the British steel industry is not prepared to reopen negotiations for membership of the Cartel. A meeting of the Cartel is being held in Paris to-day (Thursday) to discuss the inclusion of the Czecho-Slovak and Austrian steelworks.

Japanese Pig-iron Imports

It is reported from Tokyo that the Joint Pig-Iron Marketing Company, which successfully concluded a contract with Soviet Russia for the importation of 40,000 tons of Russian pig-iron this year, is negotiating with the Tata Iron & Steel Company for 250,000 tons of Indian pig-iron for delivery next year. The contract is to cover the increased consumption of pig-iron in Japan.

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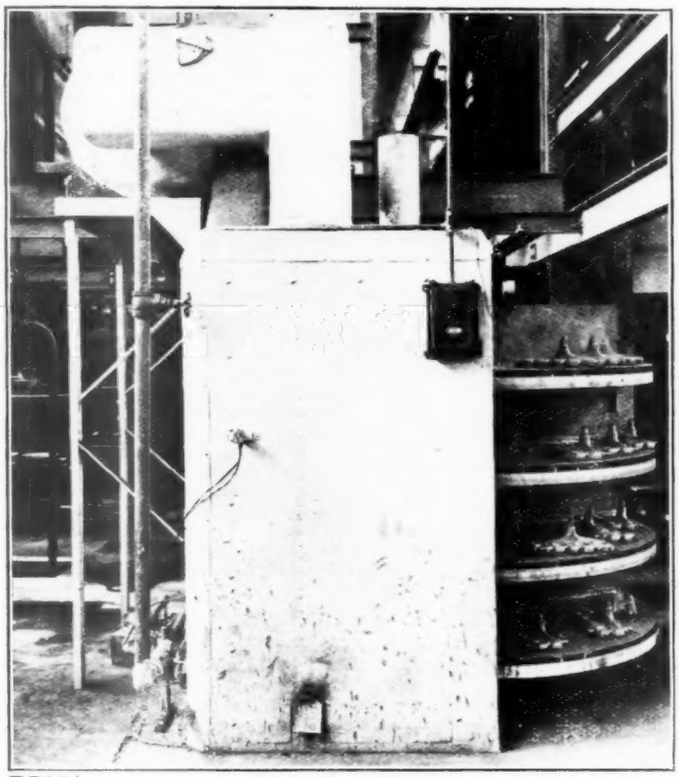

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This Week's News in Brief

Trade Talk

MESSRS. HURST NELSON & COMPANY, LIMITED, Flemington Works, Motherwell, have received from the Indian State Railways an order for a number of carriages.

H.M. DESTROYER "Eclipse," built by Messrs. Denny Bros. & Company, Limited, Dumbarton, under the 1931 programme, carried out acceptance trials on the Firth of Clyde last week.

AN ADDITIONAL FURNACE has been started at Messrs. Stewarts and Lloyds' Clydesdale steelworks, Mossend, this week, to serve the billet plant. It will mean the employment of about 50 additional men.

THE BURNTISLAND SHIPBUILDING COMPANY has secured an order for a coal- and timber-carrying steamer of 2,850 tons deadweight. The vessel will be fitted with triple-expansion engines supplied by Messrs. David Rowan & Company, Limited, of Glasgow.

TO ENSURE RELIABLE OPERATION of the hydraulic attachments of their Hydrofeed cold-sawing machine, S. Russell & Sons, Limited, of Leicester, are making use of the superior pressure tightness offered by iron castings containing a small percentage of nickel.

IT WAS REPORTED to the Ebbw Vale Council by Mr. D. Derby, last week, that the impression given him as a result of a recent interview with Welsh Members of Parliament was that negotiations were proceeding with a view to restarting the Ebbw Vale iron and steel works. The local M.P., he added, would make a full statement on the position as soon as possible.

A RESOLUTION PUTTING THE Motherwell Iron & Steel Company, Limited, into voluntary liquidation was passed on November 27, at a meeting of the shareholders of the company, held in Glasgow. Mr. Alexander Murdoch, C.A., was appointed liquidator. The appointment of the liquidator was later confirmed at a meeting of the creditors of the company.

THE ENGINEERING INDUSTRY in Dundee, which for a considerable time has been inactive in all departments, has during the past few weeks shown some revival. The Blackness Foundry, the largest establishment in the city, has received several substantial orders for mill machinery, which will keep the works busy for a considerable time. Several of the smaller works have also experienced a distinct revival.

AN ADDITION to Glasgow's industries—the manufacture of electrodes for electric-arc welding—is to start operation shortly at Levernshields works at Nitshill. The company, which is to produce the electrodes is the Sureare Electrode Company, Limited, of London, Newcastle, Manchester, Birmingham and Aberdeen. The Scottish Asbestos Company, Limited, at present manufacture asbestos at Levernshields works, and this will be continued alongside the new process. The development is of some importance, in view of the increasing use of welding in shipbuilding and allied industries. The company have recently perfected special electrodes for welding thin sheet steel, and have provisionally protected an electrode holder which is considered to be of utility in welding operations.

THE GLASGOW MUNICIPAL TRANSPORT COMMITTEE, at a special meeting this week, allocated, subject to confirmation by the Corporation, contracts for 110 Diesel-engined double-decked buses. They recommend the purchase of 60 Leyland buses, complete, as the Leyland offer was the lowest. It was further agreed to recommend the purchase of 30 Albion chassis with Beardmore engines and Cowieson bodies, and also 20 Albion chassis with Gardiner (Manchester) engines and Cowieson bodies. The buses are of the standard type, seated for 52, with all-metal bodies, and the average price is about £1,500. It was stated that the experimental bus in Glasgow was able to run nearly double the mileage with the Diesel heavy-oil engine as compared with the petrol engine in ordinary use.

INDUSTRIAL VEHICLES, LIMITED (IRELAND), of Athy, County Kildare, who have received a trade loan guarantee of £4,000 from the Free State Government, under the terms of the trade loan guarantee Act, propose erecting a foundry for the manufacture of rain-water fittings, grates, ranges and other cast-iron goods, including gutters, soil pipes and lavatory cisterns. The foundry, which it is hoped to have going in less than six weeks' time, will provide considerable employment both for skilled and unskilled workers. At present a number of the firm's hands are receiving special training at foundries in England. There is at present an enormous demand for rain-water goods in the Free State, consequent upon the house-building boom, and Captain Hosie, the firm's managing director, states that the new concern will be able to meet that demand. The new industry is really an extension of the firm's business of manufacturing tractor trailers and trailer accessories.

THE SINGER MANUFACTURING COMPANY have decided to open another branch factory near Paris. This may not come as a surprise to those conversant with recent trading conditions in France, but may be the cause of about 1,500 Clydebank workers losing their employment. Vexatious regulations, restrictive import quotas and Customs delays have combined to bring ordinary trade in sewing machines almost to a standstill. Yet there are no lack of orders. France has been requiring about 60,000 per annum, and rather than lose the valuable market the Singer Company have been compelled to begin manufacturing in France. An existing factory has been secured near Paris, to where plant and tools will be transferred from Clydebank. Six Clydebank officials, who have been instructing Italian workers and supervising production at Monza, will leave there for Paris as soon as their work is finished. It is hoped that the company will arrange to transfer the manufacture of some of the types of machine now made exclusively in America to Clydebank, and the decision already made to transfer one such type gives some hope to the displaced workers.

Industrial Lighting in Sheffield Foundries and Steelworks

(*Concluded from page* 358)

working hazards. In fettling shops, lighting is often extremely poor. In comparison a few foundries recently re-lit show a striking contrast.

Many heavy engineering shops are less well lit than might be expected. General lighting, inadequately maintained and developed, makes accurate observation difficult, and carbon filament hand-lamps are frequently resorted to. Such lighting is unsatisfactory, and one large firm is introducing portable floodlighting stand lamps. Among lighter engineering works, there is a tendency to revert to exclusively general lighting, eliminating all local points.

Contracts Open

Guilden Sutton, December 11.—4,580 yds. of spun-iron water pipes, 4 in. and 3 in. dia., for the Tarvin Rural District Council. Mr. H. Grant Bailey, clerk to the Tarvin Rural District Council, Westminster Buildings, Newgate Street, Chester. (Fee £3 3s., returnable.)

Kiveton Park, January 10.—Spun-iron concrete-lined pipes and special castings, for the Kiveton Park Rural District Council. Messrs. Elliott & Brown, Burton Buildings, Parliament Street, Nottingham. (Fee £3 3s. returnable.)

Middlesbrough, December 10.—Iron and steel castings, bolts and nuts, brass and copper work, for the Tees Conservancy Commissioners. Mr. F. T. Nattrass, general manager, Middlesbrough.

Company Reports

Stewarts and Lloyds of South Africa, Limited.—Dividend of 3 per cent. on the 6 per cent. first cumulative preference shares for the half-year to December 31, 1934.

Cargo Fleet Iron Company, Limited.—Dividend of 1½ per cent. on the ordinary shares for year; brought in, £192,263; to reserve, £100,000; depreciation, £40,000; carried forward, £93,454.

British Electric Transformer Company, Limited.—Profit for year ended September 30, £40,280; brought in, £1,049; final dividend of 10s. 3d. a share on the ordinary shares, making 15s. 3d. for the year; carried forward, £1,297.

Personal

MR. J. HAMILTON HOULDSWORTH, Castlebank, Lanark, the chairman of the Coltness Iron Company, Limited, has presented a silver cup for competition amongst the members of the works Institute, Badminton Club.

MR. W. BLAIR, works metallurgist, presided at the annual supper smoker of the Golf Club connected with Messrs. R. & A. Main's Gothic Foundry, Falkirk, in the Station Hotel, Larbert, last Friday. In the course of the proceedings, Mr. G. Wortley, works manager, presented the prizes won during the season.

DR. J. W. MELLOR, F.R.S., President of The Institute of Vitreous Enamellers, has retired from the North Staffordshire Technical College, Stoke-on-Trent. His present business address is: The British Refractories Research Association, The Mellor Laboratories, Shelton, Stoke-on-Trent.

MR. W. H. WHITTLE, chairman of The Institute of Vitreous Enamellers, resigned his position as managing director of the Protector Lamp & Lighting Company, Limited, at the end of November. A new company is being promoted under the title of W. H. Whittle, Limited, Eccles, of which he will be managing director.

PROFESSOR SIR THOMAS HUDSON BEARE, of the Engineering Department of Edinburgh University, has been elected by the Council of the Institution of Mechanical Engineers an honorary life member of the Institution, in view of his eminent scientific attainments. The distinction is the highest the Institution can bestow.

MR. E. R. BRIGGS, M.INST.C.E., M.I.MECH.E., has severed his connection with the English Electric Company, Limited. He has been actively engaged for many years in the design of power stations and in the development and manufacture of steam engines and turbines, oil engines and water turbines at the Rugby Works (formerly Messrs. Willans & Robinson, Limited) of the company.

MR. AND MRS. ROBERT GRAHAM, of North Street, Bainsford, Falkirk, this week celebrated their golden wedding anniversary. Mr. Graham, who is 79 years of age, enjoys the distinction of being one of the few surviving tradesmen who worked on the Forth Bridge during its construction. He went to Falkirk 32 years ago to an appointment with Carron Company, and later went to Gowanbank Foundry until his retirement five years ago.

MR. THOMAS C. MUIR, cogging and plate-mill foreman of Dalzell Steel Works, Motherwell, was made a presentation on the occasion of his retirement from active duty. Mr. J. M. Colville, works manager, in handing over a wristlet watch to Mr. Muir, paid fitting tribute to his long service with the firm, and wished him all good luck and happiness in the future. A platinum diamond ring was also presented to Mrs. Muir.

Obituary

WE REGRET TO ANNOUNCE the death of Mr. Louis Henry Viez, a director of the Avebene Company, one of the principal firms supplying core oils in France.

MR. GEORGE RUSHWORTH, director of George Crossley, Limited, Albion Ironworks, Cleckheaton, has died at the age of 56. Mr. Rushworth began work for the Crossley undertaking at the age of 16, and rose to be works manager, and subsequently a director.

THE DEATH HAS OCCURRED, at the age of 77, of Mr. James Fearnside, of Samuel Fearnside & Son, iron-founders, Keighley. He was the eldest son of the founder, and retained his active connection with the business until quite recently. He was a member of the Committee of the Keighley Section of the Engineering Employers' National Federation, of the Keighley Association of Engineers, and the Committee of the Keighley Stone Exchange.

MR. ROBERT TAYLOR, who has died at the age of 84, was connected all his life with the light-castings industry, serving for over 40 years with Messrs. Dobbie Forbes & Company, Limited, Larbert Foundry, in charge of the shipping department. Prior to his recent retirement from active work, he was on the staff of Messrs. R. Taylor & Company, Limited, Muirhall Foundry, Larbert, a concern which was inaugurated by his son.

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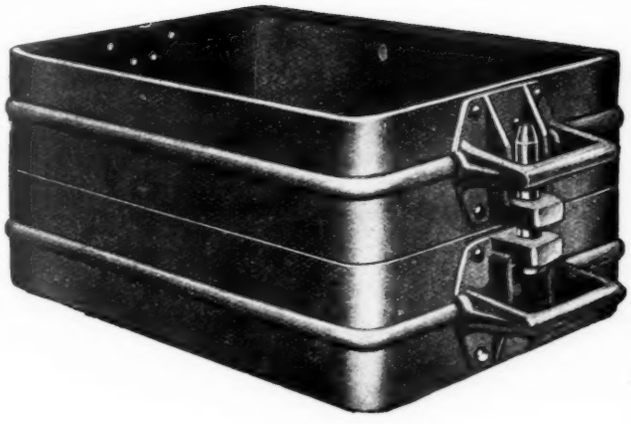

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Raw Material Markets

The general demand for pig-iron is maintained at a rate which should shortly necessitate the relighting of an additional furnace or two. Stocks are still in existence at the furnaces, but these are being steadily eaten into. There has again been a slight lessening of activity in some sections of the light-castings trade, but it is hoped that this will prove to be merely a temporary feature.

Pig-Iron

MIDDLESBROUGH.—Cleveland foundry iron remains in strong demand. The fact that the volume of current business has fallen off is of little significance in view of the heavy buying that has recently been witnessed. The makers are not seeking export business, the home market being far more remunerative, but a small amount of overseas trading is being done by merchant houses. There has been no deviation from the fixed scale of prices to home consumers, which are based on No. 3 Cleveland G.M.B. at 67s. 6d. delivered Middlesbrough.

There are ten furnaces producing hematite on the East Coast, but their output is not sufficient to satisfy the demand, and further withdrawals are having to be made from stocks at the works. Home delivered prices for No. 1 hematite vary for the different zones, the Middlesbrough rate being 69s. per ton. Export trade is fair, the prices realised averaging about 62s. 6d. per ton f.o.b.

LANCASHIRE.—The rather dull tone in the pig-iron market in this area is merely an indication of the approach of the year-end. The furnaces have well-filled order-books for the next three or four months, and delivery specifications are coming forward from consumers at a satisfactory rate. The aggregate consumption of pig-iron in Lancashire during November, judging from the experience of one or two of the leading Midland producers, has compared favourably with October. Midland brands—Staffordshire and Derbyshire—and also Lancashire No. 3 foundry iron, for delivery in the Lancashire zone, are at 74s. per ton, with Northants at 72s. 6d. and Scottish foundry at around 82s. 6d.

MIDLANDS.—Several of the largest works in this area engaged in the light-castings trade have gone on to short time, and there is not the amount of work about that there was some months ago. Activity in other sections of the iron-consuming trades shows no falling off, however, and the market maintains its optimistic tone. There have been no alterations in values. Midland brands of iron are controlled and the prices delivered to Birmingham and Black Country stations, subject to rebate to large users, are 67s. 6d. per ton for Northants No. 3 and 71s. for Derbyshire, Lincolnshire and North Staffordshire No. 3. Medium-phosphorus irons are quoted at 72s. 6d. to 80s., Scottish No. 3 and irons of similar analysis at from 85s. to 87s. 6d., and special refined iron for Diesel-engine and similar work at £5 7s. 6d. to £6 10s. per ton delivered Midland stations. The hematite market remains firm, and Welsh and East Coast No. 3 irons are offered at £3 18s. and West Coast at £4 4s. 6d. per ton delivered Birmingham and Black Country area.

SCOTLAND.—There is a steady, but limited, demand for Scottish foundry iron, the quotation for No. 3 remaining at 70s. f.o.t. furnaces, with 2s. 6d. extra for No. 1. There is no sign of any slackening of activity at the Falkirk and district light foundries. They are importing heavy tonnages of Cleveland iron, which continues to be quoted at 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow.

Coke

No change in the situation with regard to cupola coke can be observed. Quotations for delivery in the Birmingham area remain firm and are as follow:—Best Durham coke, 36s. to 40s.; Welsh coke, 35s. to 45s.; Scottish low-ash coke, about 40s. per ton.

Steel

Steady conditions continue to rule in the steel markets, and there is little sign of the decline in the demand which usually makes itself felt at this time of the year, says the official report of the London Iron and Steel Exchange. In one or two departments the volume of business has fallen off slightly, but this has been made up by gains in other sections of the industry. In the semi-finished-steel section of the market, business has been rather more active, but consumers do not seem inclined to commit themselves to long-period contracts. The manufacturers have a moderate amount of work on hand, and steady deliveries are being made to the consuming trades. Most departments of the market for finished steel are experiencing a brisk demand. Business, however, is principally upon home account, and there are indications that the requirements of consumers in this country are increasing. Some expansion in export trade is noticeable, but progress in this direction is slow.

Scrap

Scrap-iron prices are generally firm. In the Cleveland area, good foundry cast-iron scrap is 51s. 6d. to 53s., with machinery metal in handy sizes at upwards of 53s. 6d. per ton. There is a steady demand for scrap in the Midlands, at unchanged prices. In South Wales there is a rather better demand for all classes of cast iron, and good heavy metal has improved to 48s. 6d. to 51s. Scrap prices are generally firm in Scotland, quotations being in the neighbourhood of 55s. 6d. for machinery cast-iron scrap in pieces suitable for foundry cupolas.

Metals

Copper.—The uncertainty of the outlook with regard to restriction continues to exercise its influence upon the market, and values have been uncertain during the past week. There is quite a substantial demand for copper in this country, although in one or two quarters there is evidence of slight seasonal slacking-off.

Daily market prices:—

Cash.—Thursday, £27 3s. 9d. to £27 6s. 3d.; Friday, £27 2s. 6d. to £27 3s. 9d.; Monday, £26 16s. 3d. to £26 17s. 6d.; Tuesday, £26 17s. 6d. to £26 18s. 9d.; Wednesday, £27 3s. 9d. to £27 5s.

Three Months.—Thursday, £27 11s. 3d. to £27 12s. 6d.; Friday, £27 8s. 9d. to £27 10s.; Monday, £27 2s. 6d. to £27 5s.; Tuesday, £27 3s. 9d. to £27 5s.; Wednesday, £27 11s. 3d. to £27 12s. 6d.

Tin.—It is estimated that world visible supplies of tin fell by 1,782 tons during November, to 14,453 tons. The market has remained very steady.

Messrs. Rudolf Wolff report that "Business with consumers in this country is satisfactorily maintained and a rather better demand is reported from the Continent. Developments, however, in the United States of America, though showing some improvement, are still disappointing; there would seem to be evidence that industrial conditions generally are improving, but there has so far not followed any very marked expansion in demand."

Price fluctuations:—

Cash.—Thursday, £228 12s. 6d. to £228 15s.; Friday, £228 10s. to £228 15s.; Monday, £228 7s. 6d. to £228 10s.; Tuesday, £228 7s. 6d. to £228 12s. 6d.; Wednesday, £228 7s. 6d. to £228 10s.

Three Months.—Thursday, £229 to £229 5s.; Friday, £228 17s. 6d. to £229; Monday, £228 17s. 6d. to £229; Tuesday, £228 17s. 6d. to £229; Wednesday, £228 15s. to £228 17s. 6d.

Spelter.—The zinc situation presents no new feature. There is a steady demand from the consuming trades, but the impending dissolution of the Cartel continues to over-shadow the market, calling for a certain amount of caution on the part of buyers and sellers alike.

Day-to-day quotations:—

Ordinary.—Thursday, £11 18s. 9d.; Friday, £11 18s. 9d.; Monday, £11 18s. 9d.; Tuesday, £11 18s. 9d.; Wednesday, £11 16s. 3d.

Lead.—The lead market has further weakened. The Empire producers continue to ask about £1 per ton premium for early shipments.

Price fluctuations have been as follow:—

Soft Foreign (Prompt).—Thursday, £10 13s. 9d.; Friday, £10 13s. 9d.; Monday, £10 7s. 6d.; Tuesday, £10 7s. 6d.; Wednesday, £10 6s. 3d.

THE HEAVIEST PEAL OF SIX BELLS in Devon belongs to Colyton parish church, and they have just been recast, retuned and rehung by a Croydon firm. A main feature of the new fitting is a cast-iron headstock or yoke, in place of the old wooden one, this having the effect of counterbalancing to some extent the weight of the bells, making them easier to ring and reducing the thrust on the frame of the tower.

Publication Received

One Hundred Years, 1834-1934. Published by George Cohen, Sons & Company, Limited, 600, Commercial Road East, London, E.14.

Before reviewing this masterpiece of present-day publicity, we wish to tender to the House of Cohen—they are entitled to such an appellation after a hundred years of enterprise—our very sincere congratulations on attaining their century, especially when it carries the cricketing term of "not out." Whilst hoary in industry, they are still neophytes in foundry practice, yet since they acquired the business of Messrs. Kryn & Lahy, of Letchworth, a few years ago, this centenarian has proved itself a lusty infant, for it is now working at almost a hundred per cent. capacity. The extent of this work can be visualised by imagining a 12-in by 10-in. book containing 240 odd pages, practically every one of which is illustrated. The lay-out of the book tells us, by photographs and family tree, something of those who have been responsible for the undoubted success of the firm, and outlines in considerable detail its history, acknowledges long service from employees, records some outstanding achievements and gives an account of their associated companies.

We know little of high finance, but a reproduction of a cheque, duly honoured for £486,000, drawn in payment of surplus war stock bought from the Government, certainly impressed us, and even the erased post-dated mark failed to dim its glamour, as it has with some of those we have personally been foolish enough to cash! After all, we suppose cheques for a cool half-million need a little prenatal (or should it be predatal) care, if those ominous initials "R.D." are to be avoided. This reproduction of a cheque is typical of the "showmanship" exhibited throughout the book, and we could enlarge almost *ad infinitum* on the "high spots" constantly occurring throughout its pages. The book, as a whole, is a production of which Mr. Nye, in association with others, can be proud, and we offer our felicitations.

New Company

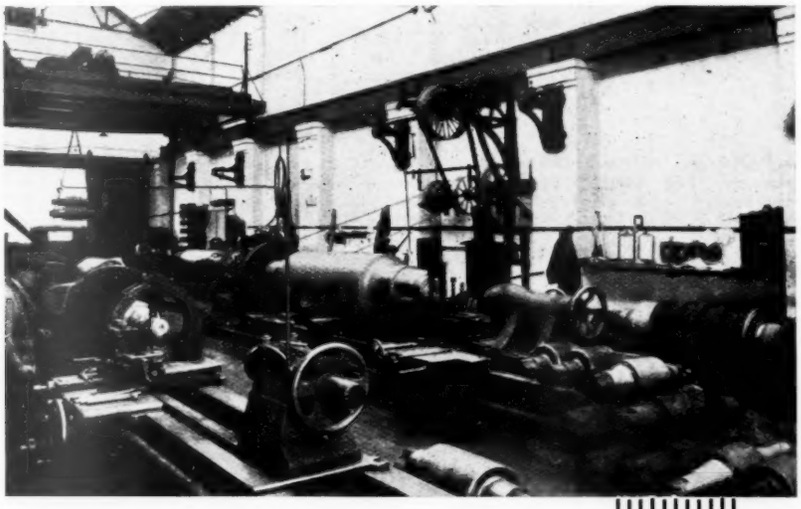
(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Sykes & Harrison, Limited, 10, Piercey Street, Ancoats, Manchester.—Capital £2,000 in £1 shares. To enter into an agreement for the acquisition of the goodwill, assets and liabilities of the business of non-ferrous founders and finishers, etc., carried on at Union Street Foundry, Ardwick, Manchester, as Sykes & Harrison; and to purchase the goodwill, etc., of the business of ironfounders carried on at Piercy Street, Ancoats, Manchester, as Alexander Dunn & Son. Directors: Mrs. E. A. Harrison and Mr. S. G. Harrison (managing director), "The Bungalow," Arnside View, Knott End, Lancs.

THE BRITISH CAST IRON RESEARCH ASSOCIATION has elected the following to various grades of membership:—Ordinary members: Babcock & Wilcox, Limited, London (representative, Mr. A. McKinstry, M.Sc., M.I.E.E., M.I.Mech.E.); T. & J. Brettell, Limited, West Bromwich (representative, Mr. C. P. Cook); Clarke, Chapman & Company, Limited, Gateshead-on-Tyne (representative, Mr. W. A. Woodeson); Copper Development Association, London (representative, Mr. D. P. C. Neave); the Frederick Crane Chemical Company, Limited, Birmingham (representative, Mr. Leslie D. Stewart); Croydon Foundry, Limited, Croydon (representative, Mr. Stuart Jervis Smith); General Industries, Limited, Melbourne (representative, Mr. R. A. Spring); International Tin Research & Development Council, London (representative, Dr. D. J. Macnaughtan, Ph.D.); James & Company (Birmingham), Limited, Halesowen (representative, Mr. G. Williams); Francis Lane, Brierley Hill (representative, Mr. F. Lane). Trade Association: British Ironfounders' Association, Glasgow. Trade member: J. Grayson Lowood & Company, Limited, Sheffield (representative, Mr. W. Stuart Goodison). Associate member: Mr. Thomas Bailey, West Bromwich.

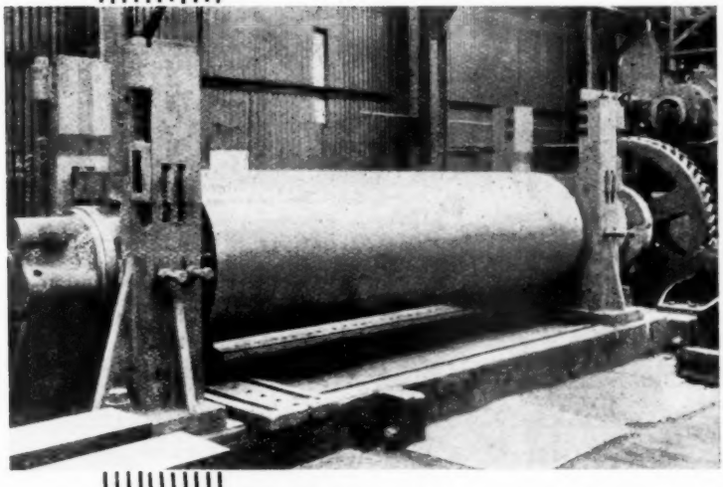
XUM

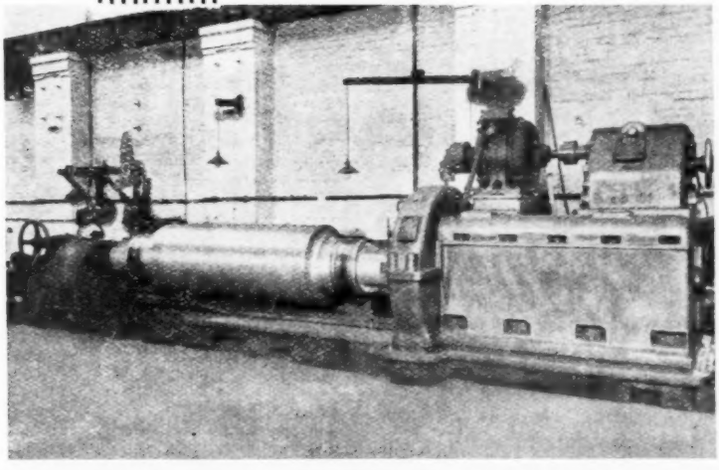
BRITISH ROLL FOUNDRIES



View in Roll Turning Shop
of
THE BRIGHTSIDE FOUNDRY AND ENGINEERING COMPANY, LTD., SHEFFIELD

Below—
GRAIN PLATE ROLL 39″ × 144″
and
CHILLED PLATE ROLL 32″ × 78″
in High Speed Heavy-Duty Roll Turning Lathe





THE BRIGHTSIDE FOUNDRY AND ENGINEERING COMPANY, LIMITED, are regular users of—

COLD BLAST PIG IRON

THE BEST IRON FOR CHILLED CASTINGS.

Brands: —

"LOWMOOR C.B."—*Makers:* The Low Moor Iron Co., Ltd., New Works, Low Moor, Yorks.
"GRAZEBROOK"—*Makers:* M. & W. Grazebrook, Ltd., Dudley, Worcs.
"DUD·L.N.F'ces·DUD"—*Makers:* The Earl of Dudley's Round Oak Works, Ltd., Brierley Hill.

XUM

RAW MATERIALS—PRICE LIST

(Wednesday, December 5, 1934)

COPPER

	£	s.	d.
Standard cash	27	3	9
Three months	27	11	3
Electrolytic	30	10	0
Tough	29	0	0
Best selected	29	10	0
Sheets	58	0	0
India	40	0	0
Wire bars	30	10	0
Ingot bars	30	10	0
H.C. wire rods	33	10	0
Off. av. cash, November	27	5	5 3/4
Do., 3 mths., November	27	12	0 9/16
Do., Sttlmnt., November	27	5	5 5/16
Do., Electro, November	30	10	4 1/2
Do., B.S., November	30	3	7 1/8
Do., wire bars, November	30	16	4 1/16
Solid drawn tubes			9 1/2d.
Brazed tubes			9 1/2d.
Wire			6d.

BRASS

Solid drawn tubes	8 3/4d.
Brazed tubes	10 1/4d.
Rods, drawn	8d.
Rods, extd. or rlld.	4 1/4d.
Sheets to 10 w.g.	7d.
Wire	7d.
Rolled metal	6 1/2d.
Yellow metal rods	4 1/4d.
Do. 4 × 4 Squares	5 1/2d.
Do. 4 × 3 Sheets	5 1/2d.

TIN

	£	s.	d.
Standard cash	228	7	6
Three months	228	15	0
English	228	12	6
Bars	230	12	6
Straits	230	7	6
Australian (nom.)		—	
Eastern	230	10	0
Banca	229	17	6
Off. av. cash, November	228	13	4 10/11
Do., 3 mths., November	228	16	0 2/11
Do., Sttlmt., November	228	13	10 1/11

SPELTER

	£	s.	d.
Ordinary	11	16	3
Remelted	13	0	0
Hard	10	10	0
Electro 99.9	14	8	9
English	13	0	0
India	12	0	0
Zinc dust	17	0	0
Zinc ashes	3	0	0
Off. aver., November	12	2	9 3/4
Aver. spot, November	12	0	0

LEAD

	£	s.	d.
Soft foreign ppt.	10	6	3
Empire (nom.)	11	11	3
English	12	10	0
Off. average, November	10	10	3 9/22
Average spot, November	10	8	7 7/11

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	10	0
Do., V.M. ex whse.	22	17	6
Rods	26	12	6

ANTIMONY

	£	s.	d.
English	65	0	0
Chinese, ex-whse.	59	0	0
Crude	—		

QUICKSILVER

Quicksilver 11 2 6 to 11 10 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	13 0 0
75%	18 7 6
Ferro-vanadium—	
35 50	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	5/3 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	3/– lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	29 15 0
4/6% car.	23 0 0
6/8% car.	21 12 6
8/10% car.	21 12 6
Ferro-chrome—	
Max. 2% car.	34 0 0
Max. 1% car.	38 15 0
Max. 0.70% car.	42 0 0
70% carbon-free	10d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under 1/4 in. to 1/2 in.	3d. lb.
Do., under 1/2 in. to 5/16 in.	1/– lb.
Flats, 1/2 in. × 1/4 in. to under 1 in. × 3/8 in.	3d. lb.
Do., under 1/2 in. × 1/4 in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel				2	15	0
Bundled shrngs.				2	7	6
Mixed iron and steel	2	10	0	to 2	12	0
Heavy cast iron	2	8	0	to 2	11	0
Good machinery	2	12	6	to 2	16	0
Cleveland—						
Heavy steel	2	10	0	to 2	12	6
Steel turnings				1	15	0
Cast-iron borings				1	5	0
Heavy forge				2	10	0
W.I. piling scrap				2	5	0
Cast-iron scrap	2	11	6	to 2	15	0
Midlands—						
Light cast-iron scrap				2	7	6
Heavy wrought iron				3	0	0
Steel turnings, f.o.r.				1	14	0
Scotland—						
Heavy steel				2	10	0
Ordinary cast iron				2	12	6
Engineers' turnings				1	19	6
Cast-iron borings				1	17	6
Wrought-iron piling				2	11	3
Heavy machinery				2	15	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	24	0	0
Brass	16	10	0
Lead (less usual draft)	10	0	0
Tea lead	7	0	0
Zinc	9	0	0
New aluminium cuttings	66	0	0
Braziery copper	19	0	0
Gunmetal	23	0	0
Hollow pewter	150	0	0
Shaped black pewter	112	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/–
Foundry No. 3	67/6
„ at Falkirk	67/3
„ at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/–
Hematite M/Nos.	68/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
„ d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/–
„ No. 3 fdry.	71/–
Northants forge	63/6
„ fdry. No. 3	67/6
„ fdry. No. 1	70/6
Derbyshire forge	67/–
„ fdry. No. 3	71/–
„ fdry. No. 1	74/–
Scotland—	
Foundry No. 1, f.o.t.	72/6
„ No. 3, f.o.t.	70/–
Hem. M/Nos. d d	71/–
Sheffield (d/d district)—	
Derby forge	64/6
„ fdry. No. 3	68/6
Lincs forge	64/6
„ fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/–
Staffs fdry. No. 3	74/–
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	9	12	6	to 9	15	0
Nut and bolt iron	7	10	0	to 8	0	0
Hoops	10	10	0	and up.		
Marked bars (Staffs) f.o.t.		12	0	0		
Gas strip	10	10	0	and up.		
Bolts and nuts, 3/4 in. × 4 in.	14	0	0			
Steel—						
Plates, ship, etc.	8	15	0	to 8	17	6
Boiler plts.	9	5	0	to 9	7	6
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5 1/2 in.				9	7	6
Rounds under 3 in. to 3/8 in. (Untested)				8	12	0
Flats—8 in. wide and over				8	12	6
„ under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0	to 8	10	0
Fishplates	12	5	0	to 12	10	0
Hoops (Staffs)				9	7	0
Black sheets, 24g. (4-t. lots)				10	10	0
Galv. cor. shts. („)				13	0	0
Galv. flat shts. („)				13	10	0
Galv. fencing wire, 8g. plain				14	10	0
Billets, soft	5	10	0	and up.		
Billets, hard	6	17	6	to 7	2	6
Sheet bars	5	0	0	to 5	7	6
Tin bars	5	2	6	to 5	7	6

PHOSPHOR BRONZE

	Per lb. basis
Strip	9d.
Sheet to 10 w.g.	10d.
Wire	11d.
Rods	10d.
Tubes	13d.
Castings	10 1/2d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1 1/2 to 1/7 1/2
To 15 in. wide	1/1 1/2 to 1/7 1/2
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2 1/2 to 1/8 1/2
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3 1/2
Ingots rolled to spoon size	10d. to 1/6 1/2
Wire round—	
to 10g.	1/4 1/2 to 1/11 1/2

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3 1/2 upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37 1/2
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/– to 30/–
„ furnace	19/– to 20/–
Durham foundry	20/– to 25/–
„ furnace	17/6
Midlands, foundry	—
„ furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/2 to 18/6
„	28×20 „	36/4 to 37/–
„	20×10 „	26/– to 26/6
„	18 3/4×14 „	18/9 to 19/–
C.W.	20×14 „	15/6 to 16/6
„	28×20 „	34/– to 35/–
„	20×10 „	23/3 to 23/6
„	18 3/4×14 „	16/3 to 16/6

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6	0	0	to £7	0	0
Bars-hammered, basis	£16	0	0	to £16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to £16	0	0
Blooms	£10	0	0	to £12	0	0
Keg steel	£30	0	0	to £31	0	0
Faggot steel	£18	0	0	to £23	0	0
Bars and rods dead soft, st'l	£10	0	0	to £12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
Nov.	29 ..	27 3 9	dec. 6/3
,,	30 ..	27 2 6	,, 1/3
Dec.	3 ..	26 16 3	,, 6/3
,,	4 ..	26 17 6	inc. 1/3
,,	5 ..	27 3 9	,, 6/3

Electrolytic Copper

		£ s. d.	
Nov.	29 ..	30 10 0	No change
,,	30 ..	30 5 0	dec. 5/-
Dec.	3 ..	30 0 0	,, 5/-
,,	4 ..	30 0 0	No change
,,	5 ..	30 10 0	inc. 10/-

Standard Tin (cash)

		£ s. d.	
Nov.	29 ..	228 12 6	dec. 22/6
,,	30 ..	228 10 0	,, 2/6
Dec.	3 ..	228 7 6	,, 2/6
,,	4 ..	228 7 6	No change
,,	5 ..	228 7 6	,, ,,

Tin (English ingots)

		£ s. d.	
Nov.	29 ..	228 17 6	dec. 20/-
,,	30 ..	228 17 6	No change
Dec.	3 ..	228 12 6	dec. 5/-
,,	4 ..	228 12 6	No change
,,	5 ..	228 12 6	,, ,,

Spelter (ordinary)

		£ s. d.	
Nov.	29 ..	11 18 9	No change
,,	30 ..	11 18 9	,, ,,
Dec.	3 ..	11 18 9	,, ,,
,,	4 ..	11 18 9	,, ,,
,,	5 ..	11 16 3	dec. 2/6

Spelter (Electro, 99.9 per cent.)

		£ s. d.	
Nov.	29 ..	14 11 3	No change
,,	30 ..	14 11 3	,, ,,
Dec.	3 ..	14 11 3	,, ,,
,,	4 ..	14 11 3	,, ,,
,,	5 ..	14 8 9	dec. 2/6

Zinc Sheets (English)

		£ s. d.	
Nov.	29 ..	23 10 0	No change
,,	30 ..	23 10 0	,, ,,
Dec.	3 ..	23 10 0	,, ,,
,,	4 ..	23 10 0	,, ,,
,,	5 ..	23 10 0	,, ,,

Lead (English)

		£ s. d.	
Nov.	29 ..	12 15 0	No change
,,	30 ..	12 15 0	,, ,,
Dec.	3 ..	12 10 0	dec. 5/-
,,	4 ..	12 10 0	No change
,,	5 ..	12 10 0	,, ,,

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1898	2 7 6	2 8 0	2 8 0	2 8 0	2 8 6	2 10 0	2 10 0	2 10 0	2 10 0	2 11 0	2 14 0	2 14 0	2 9 11
1899	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	3 16 6	4 0 0	3 6 2½
1900	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 1 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 3½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	•	•	•	•	4 12 6	4 0 1½
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 8½	4 1 6½
1928	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 7 6	3 9 10½
1929	3 8 3½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	3 14 6	3 15 1½	3 17 0	3 17 0	3 17 0	3 13 1½
1930	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 15 0	3 12 0	3 12 0	3 12 6	3 10 1½	3 9 6	3 14 4½
1931	3 9 6	3 9 6	3 9 6	3 9 6	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 10
1932	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0
1933	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0
1934	3 7 0	3 9 6	3 13 2½	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	—	—

* No prices available during strike period.

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